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VOL. CXLV.—No. 3775] LONDON: FRIDAY EVENING, MAY 18, 1928 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

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PUBLIC NOTICES

The Director-General, India Store Department, Belvedere road, Lambeth, S.E. 1, invites TENDERS for :—
SCHEDULE 1.—60 SETS of FITTINGS for ROCKING GRATES of LOCOMOTIVES.
SCHEDULE 2.—208 PAIRS WHEELS and AXLES for CARRIAGES and WAGONS (Metre Gauge).
SCHEDULE 3.—SUPPLY and ERECTION at Vizagapatam of ELECTRIC PORTAL QUAY CRANES :—
Lifting capacity 5 tons, One.
Lifting capacity 1½ tons, Ten.
Tenders due on the 5th June, 1928, for No. 1; on the 8th June, 1928, for No. 2; and on the 12th June, 1928, for No. 3.
Forms of Tender obtainable from the above at a fee (which will not be returned) of 5s. for each Schedule. 8522

A Test Assistant is REQUIRED at the ROYAL AIRCRAFT ESTABLISHMENT for Calculation Work in connection with Engine Investigations.
Candidates should have had technical training to the standard of the B.Sc. Degree and, preferably, some works and drawing-office experience.
Ex-Service man preferred.
Starting salary about 60s. p.w., plus Civil Service bonus, giving present total remuneration of 92s. 7d.
Write, quoting A. 275, giving full particulars of qualifications, to CHIEF SUPERINTENDENT, Royal Aircraft Establishment, S. Farnborough, Hants. 8496

Assistant Engineers (4) REQUIRED by the GOVERNMENT of the GOLD COAST for a tour of 12 to 18 months' service, with possible extension. Salary £480 a year for three years, then £510, rising to £920 a year, by annual increments. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 35, must be Corporate Members of the Institution of Civil Engineers or hold an Engineering Degree or Diploma recognised as granting exemption from Sections A and B of the A.M.I.C.E. examinations. Must be capable of taking complete charge of construction of buildings, bridges and roads, and have a thorough knowledge of surveying, quantities and measuring up of work.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/628. 8519

Assistant Engineers (22) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. The foregoing officers are required to fill vacancies caused by the increase of the establishment of the Nigeria Public Works Department. Salary £480 a year for the first three years, then £510, rising by annual increments to £920. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates must have attained the age of 21½ years on the date of appointment, and should preferably have attained the age of 22½ and must not be over 35 years of age. Must have obtained an Engineering Degree at a recognised University or have passed Sections "A" and "B" of the A.M.I.C.E. Examination or have passed the Associateship in Civil Engineering of the City and Guilds Institute, or possess such other Degree or Diploma or Distinction in Engineering as may be considered satisfactory. Candidates whose qualifying Diplomas have been obtained without a College course should have had three years' practical experience of Civil Engineering under a qualified civil engineer. It is preferred that all candidates should have had two years' practical experience on good engineering work, subsequent to taking their degree or completing their articles, but under certain conditions this may be waived in the case of candidates in possession of an Engineering Degree.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1, quoting M/254. 8397

Civil Engineer Re- QUIRED by the GOVERNMENT of the BAHAMAS to fill the POST of DEPUTY DIRECTOR OF PUBLIC WORKS for one to two years' service, in the first instance, with the possibility of then being placed upon the permanent and pensionable establishment. Salary £550 a year. Quarters and free passages are not provided. Candidates, preferably unmarried, 25 to 35 years of age, must be Corporate Members of the Institution of Civil Engineers, with several years' experience on large Engineering Works, such as are undertaken by Municipalities, particularly in Road and Building Construction, Surveys, Water Supply and Sanitation. Preparation of Plans and Specifications, &c.—Apply at once by letter, stating age, qualifications and experience, and whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1, quoting M/623. 8517

Safety in Mines Re- SEARCH BOARD.
The Safety in Mines Research Board invite APPLICATIONS for TWO POSTS of PHYSICIST and ONE of JUNIOR ENGINEER.
Candidates for the Physicist posts must possess good scientific qualifications, including a University Degree (or its equivalent) and Electrical Engineering Experience.
Candidates for the Junior Engineer's post, which is in connection with research on colliery wire ropes, must possess good scientific qualifications, including a University Degree (or its equivalent) in Engineering, have a good knowledge of Electricity and be good Draughtsmen. Special knowledge of Metallurgy is not required.
Other things being equal, preference will be given to ex-Service men.
The posts are graded as Junior Assistants with a scale of salary of £160 per annum, rising by annual increments of £10 to £190. In addition, a variable cost-of-living bonus is payable, making the present minimum of the scale £246.
The posts are whole-time ones, the Physicist's being tenable in Sheffield and the Engineer's in London. Successful candidates will be required to commence duty about 2nd July.
Forms of application, which must be returned not later than 29th May, can be obtained from the UNDER SECRETARY FOR MINES, Establishment Branch Mines Department, Dean Stanley-street, London, S.W.1. 8495

The Superintendent of DESIGN, Royal Arsenal, Woolwich, S.E. 18, invites APPLICATIONS for the POST of 1ST CLASS ASSISTANT, to deal with the Design of Automobile Chassis and of body Details. Previous experience of such work and qualifications equivalent to Corporate Membership of the Institution of Mechanical Engineers are essential. Salary £600-20-700, plus Civil Service bonus. Full particulars of qualifications, including age, should be forwarded with applications and names of two referees who are full members of the Institution of Civil, Mechanical or Automobile Engineers, not later than 31st May. Final selection will be by interview. Preference given to ex-Service man if fully qualified. 8494

Wanted, Engineering DRAUGHTSMEN, used to neat, small and accurate work, and with good practical training. Experience with fully toleranced drawings an advantage. Salary £125, rising in £7 10s. annual increments to £150 plus Civil Service bonus, making salary at present cost-of-living figures £200 to £232. Appointment will not exceed 3 years' period in first instance, but is terminable by 1 month's notice either side. Preference given to ex-Service men.
Applications, with testimonials, and stating experience, should be addressed to SUPERINTENDENT, R.N. Torpedo Factory, Greenock. 8506

Middlesex Education Committee APPLICATIONS are INVITED for the POST (tenable from 1st September next) of PRINCIPAL of the new ACTON TECHNICAL INSTITUTE, to be opened in the autumn in premises in course of erection at a cost of about £50,000. The Committee propose to transfer to the new Institute the existing Junior Technical School in Engineering for Boys, together with Evening Classes in Engineering (Electrical and Mechanical) and in Building Science from the Chiswick Polytechnic, Bedford Park, W. 4.
Candidates for the appointment should have a good knowledge of and experience in engineering.
The commencing salary will be at the rate of £700 per annum. The Committee have no salary scale for such appointments, but salaries are reviewed annually.
Forms of application, which may be obtained by forwarding a stamped addressed envelope, should reach the undersigned not later than Wednesday, 30th May.
B. S. GOTT,
Secretary, Middlesex Education Committee.
Education Offices,
40, Eccleston-square, Westminster, S.W. 1. 8521

PUBLIC NOTICES

MANCHESTER MUNICIPAL
COLLEGE OF TECHNOLOGY.
(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER).

Appointment of
HEAD OF THE DEPARTMENT OF PURE AND APPLIED PHYSICS.
The Governing Body invites APPLICATIONS for the POSITION of HEAD of the DEPARTMENT of PURE and APPLIED PHYSICS in the College of Technology, with the title and status of Lecturer in the University of Manchester.
Salary, £600 per annum.

Appointment of
LECTURER IN MUNICIPAL AND SANITARY ENGINEERING.
The Governing Body invites APPLICATIONS for a LECTURESHIP in MUNICIPAL and SANITARY ENGINEERING in the College of Technology.
Salary, £400 per annum.

Appointment of
ASSISTANT LECTURER IN MUNICIPAL AND SANITARY ENGINEERING.
The Governing Body invites APPLICATIONS for an ASSISTANTSHIP in MUNICIPAL and SANITARY ENGINEERING in the College of Technology.
Commencing salary, £300 per annum.
Conditions of appointment and forms of application may be obtained from the Registrar, College of Technology, Manchester. The last day for the receipt of applications is Saturday, 9th June, 1928.
Canvassing, either directly or indirectly, will disqualify a candidate for appointment.
8510 B. MOUAT JONES.

University of Birmingham.
APPOINTMENT OF ASSISTANT LECTURER IN DEPARTMENT OF METALLURGY.
APPLICATIONS are INVITED for the POST of ASSISTANT LECTURER in METALLURGY. Preference will be given to candidates with practical experience in Non-ferrous and Physical Metallurgy. Stipend £300 per annum. Duties to begin September 1st, 1928. Four copies of application, with testimonials or references, must be sent, on or before June 30th, to the undersigned, from whom further particulars may be obtained.
C. G. BURTON,
Secretary.
The University,
Edmund-street, Birmingham,
May, 1928. 8503

PUBLIC NOTICES

Warwickshire Education Com- MITTEE.
RUGBY COLLEGE OF TECHNOLOGY AND ARTS.
A FULL-TIME TEACHER is REQUIRED in September for the DEPARTMENT of MECHANICAL ENGINEERING.
Good Workshop Experience essential. Salary according to Burnham Award.
Application form and further particulars will be sent on receipt of stamped addressed envelope by the undersigned, to whom applications should be sent by 6th June, 1928.
P. I. KITCHEN,
Organiser of Further Education in Rugby.
61, Clifton-road, Rugby. 8488

Derbyshire Education Com- MITTEE.
CHESTERFIELD TECHNICAL COLLEGE.
The Governors invite APPLICATION for the POST of LECTURER in MECHANICAL ENGINEERING in the above College. Salary in accordance with the Burnham Scale for teachers in Technical Schools.
Further particulars and form of application can be obtained from the Principal, the Technical College, Chesterfield, to whom applications must be forwarded so as to be received not later than 11th June, 1928.
P. G. FEEK,
Director of Education.
County Education Office,
Derby. 8487

In the High Court of Justice. 1928 J. No. 016.
Chancery Division.
Mr. Justice Eve.
IN THE MATTER OF JAMES GORDON AND COMPANY LIMITED AND REDUCED
and
IN THE MATTER OF THE COMPANIES (CONSOLIDATION) ACT 1908.
Notice is Hereby Given that the ORDER of the High Court of Justice Chancery Division dated the 24th day of April 1928 CONFIRMING the REDUCTION of the CAPITAL of the above-named Company from £15000 to £1700 and the MINUTE APPROVED by the COURT showing with respect to the share capital of the Company as altered the several particulars required by the above Act were REGISTERED by the Registrar of Companies on the 11th day of May 1928.
Dated this 12th day of May 1928.
CHAS. G. BRADSHAW and WATERSON,
Royal London House,
16, Finsbury-square, E.C. 2.
8482 Solicitors for the said Company.

PATENTS AND DESIGNS ACTS, 1907 TO 1928.
Notice is Hereby Given that SPENCER-BONECOURT Limited, a British Company, of Broadway-buildings, 50-54, Broadway, Westminster, S.W. 1, SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 186,801, granted to Percy St. George Kirke for an invention, entitled "Improvements relating to the Cleaning of Fire-tube Boilers."
Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents) of the 9th May, 1928.
Any person or persons may give Notice of Opposition to the amendment by leaving Patents Form No. 10 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.
W. S. JARRATT,
8483 Comptroller-General.

Administrative County of LONDON.
BLACKWALL TUNNEL.—RE-PAVING OF CARRIAGEWAY.
The London County Council invites TENDERS for the RE-PAVING with GRANITE SETTS and WOOD BLOCKS of portions of the CARRIAGEWAY; also the TAKING UP and RELAYING of the existing KERBS and YORK STONE FLAGGING of parts of the FOOTWAYS of BLACKWALL TUNNEL. The work must be commenced on 13th August, 1928, and completed ready for traffic by not later than 22nd September, 1928.
Instructions for Tender, forms of Tender and contract, &c., with a copy of the drawing, may be obtained on application to the Chief Engineer of the Council at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £2 by cheque or draft to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before payment of the fee.
Correspondence and remittances by post should be addressed to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1, or, if personal application is made, applicants should apply in Room 2A at No. 3, Warwick House-street, Cockspur-street, S.W. 1.
The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in the "London County Council Gazette."
No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 4th June, 1928, will be considered.
The Council does not bind itself to accept the lowest or any Tender.
MONTAGUE H. COX,
8518 Clerk of the London County Council.

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PUBLIC NOTICES

Bengal-Nagpur Railway Company, Limited.

The Directors are prepared to receive TENDERS for :—

STEEL FOR LAMINATED SPRINGS.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 17th May, 1928.

A fee of 10s. will be charged for each specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Thursday, 31st May, 1928.

The Directors do not bind themselves to accept the lowest or any Tender and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
E. C. VOLKERS,
Secretary.

17th May, 1928. 8532

County Borough of Halifax.

WATERWORKS COMMITTEE.
GORPLE RESERVOIRS.
CAST IRON SEGMENTS FOR DISCHARGE TUNNELS.

TENDERS are INVITED for the SUPPLY of about 80 TONS of CAST IRON SEGMENT PLATES, together with BOLTS, NUTS, WASHERS, &c., for same.

Drawings may be seen and copy of specification obtained, except during Whit-week, on application to Messrs. G. H. Hill and Sons (Manchester), Civil Engineers, 40, Kennedy-street, Manchester, upon the receipt of a cheque for Two Guineas, which will be returned to the applicant, provided that he shall have sent in a bona fide Tender and shall have not withdrawn the same and shall have returned the documents lent to him.

A limited number of copies of the drawings are available, and will be lent to persons tendering in priority of application on payment of the sum of Half-a-Guinea, which sum will not be returned.

Sealed Tenders, endorsed "Tender for Cast Iron Segments, Gorple Reservoirs," and addressed to the "Chairman of the Waterworks Committee," must be delivered at the office of the Town Clerk, Town Hall, Halifax, not later than the 18th day of June, 1928.

The Committee do not bind themselves to accept the lowest or any Tender.

PERCY SAUNDERS,
Town Clerk.

Town Hall, Halifax,
16th May, 1928 8534

Great Southern Railways.

The Directors of the Great Southern Railways, Ireland, are prepared to receive TENDERS for the SUPPLY of—

POINTS and CROSSINGS.

Specification and form of Tender (on which alone offers will be considered) can be obtained on application to the Company's Stores Superintendent, Inchicore, Dublin, on payment of two shillings and sixpence.

Tenders should be forwarded so as to reach the undersigned not later than 5 p.m. on Wednesday, the 23rd May, 1928, in the envelope provided for the purpose.

The Directors do not bind themselves to accept the lowest or any Tender.

H. S. COE,
Secretary.

Kingsbridge Station,
Dublin, May, 1928. 8480

Paddington Board of Guardians.

ECONOMISER.

TENDERS are INVITED for SUPPLYING and INSTALLING at the Paddington Infirmary, 285, Harrow-road, W. 9, a new ECONOMISER, consisting of 192 Cast Iron Tubes, 4in. bore by 9ft. long, the Tenders to include all necessary building work. Full particulars may be obtained on application to Engineer at the Infirmary.

Tenders must be delivered to the undersigned before 2 p.m. on Thursday, 7th June, 1928.

The Guardians do not bind themselves to accept the lowest or any Tender.

By Order,
P. B. HANCOCK,
Clerk to the Guardians.

313-319, Harrow-road, W. 9,
11th May, 1928. 8479

Southport, Birkdale, and West Lancashire Water Board.

RECONSTRUCTION OF SCARTH HILL PUMPING STATION.

CONTRACT No. 2: OIL ENGINES AND PUMPS.

The Water Board are prepared to receive TENDERS from competent manufacturers of Bore-hole Pumps and/or Oil Engines, for the SUPPLY, ERECTION and SETTING TO WORK at the above Pumping Station, situated near Ormskirk, of TWO COMPLETE PUMPING UNITS, together with all accessories.

Each Pumping Unit must be capable of delivering 19,000 gallons of water per hour against a head of about 350ft.

Conditions of contract, specification, Tender form and lay-out plan may be obtained from the undersigned upon deposit of cheque for Two Guineas, which will be returned upon receipt of a bona fide Tender not afterwards withdrawn, and the return of all documents.

Tenders, endorsed "Scarth Hill Pumping Plant," must be delivered to the undersigned before 10 a.m. on the 18th June, 1928.

The Board do not bind themselves to accept the lowest or any Tender.

C. BURTON EDE, M. Inst. C.E.,
Engineer and Manager.

14, Portland-street, Southport,
May, 1928. 8485

Tenders are Invited by the Ministry of Public Works of The Egyptian Government for the CONSTRUCTION of (a) TWO DIPPER DREDGERS, each capable of an output of spoil in free-getting material of 80 metres cubic per hour measured in the solid; and (b) TWO SUCTION PUMP DREDGERS, each capable of an output of spoil in free-getting material of 200 metres cubic per hour measured in the solid; including RE-ERECTION in the Sudan and for the DELIVERY thereof in working order safely afloat on the River Nile.

Builders may Tender either for the two dipper dredgers or for the two suction pump dredgers, or for both groups.

Tenders will be received up to Noon on the 1st October, 1928. They must be submitted, in duplicate; one copy in Cairo to H.E. the Minister of Public Works, and the other in London to Messrs. Coode, Fitzmaurice, Wilson and Mitchell at the address given below.

The contract documents and the rules for, and full information as to, tendering may be inspected on and after June 1st, 1928, at any of the following places, namely :—

The Ministry of Public Works, Cairo.

The Offices of Messrs. Coode, Fitzmaurice, Wilson and Mitchell, Consulting Engineers to the Egyptian Government, 9, Victoria-street, Westminster, London, S.W. 1.

The Legations of the Egyptian Government at :
ENGLAND—Bute House, 75, South Audley-street, London.
GERMANY—Delbruckst 8, Grunewald, Berlin.
UNITED STATES OF AMERICA—1815 "Q"-street, N.W., Washington, D.C.
FRANCE—9, Rue la Perouse, Paris (XVIe).
BELGIUM—Rue de Turin, 1., Bruxelles.
HOLLAND—Bute House, 75, South Audley-street, London.
ITALY—Palais Berlingieri, Rome.

Persons desiring to Tender may obtain copies of the contract documents between June 1st and July 1st, 1928, from either the SECRETARY-GENERAL, Ministry of Public Works, Cairo; or Messrs. COODE, FITZMAURICE, WILSON and MITCHELL, London, upon payment of Ten Egyptian Pounds.

Attention is drawn to Clauses 11 to 14 of the Instructions to Firms Tendering, and prospective tenderers are warned that their representative must have examined the re-erection site in the Sudan before July 15th at the latest, and that no Tender will be considered unless accompanied by evidence satisfactory to the Ministry of Public Works that this condition has been fulfilled. 8438

A Story which every Engineer should read and own.

ALFRED YARROW
His Life and Work.
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REINFORCED CONCRETE DESIGN.
Vol. I.—Theory. By OSCAR FABER, D.Sc., and P. G. BOWIE. **14s.** net.
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Vol. II. contains B.M. Diagrams for beams of any span, any ratios of live to dead load and any fixity with monolithic columns of different relative stiffness.

LONDON EDWARD ARNOLD & CO 41 & 43 MADDOX ST. W

PUBLIC NOTICES

The Madras and Southern Mahratta Railway Company, Limited, invite TENDERS for—

(1) FENCING MATERIALS (comprising Steel Standards, Straining Pillars, Galvd. Eye Bolts, Galvd. Strand Wire, &c. &c.).
(2) 128,380 Lineal Feet WROUGHT IRON or MILD STEEL PIPING, together with BENDS, COUPLING SOCKETS, TEES, &c. &c.

Tenders are due in on Tuesday, 5th June, 1928, by 2 p.m.

Tender forms obtainable at address below, fee ONE GUINEA each, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices :
25, Buckingham Palace-road, Westminster, S.W. 1.
8516

ASSISTANT DOCKYARD ENGINEER.

Sudan Government Railways and STEAMERS REQUIRE the SERVICES of a thoroughly well-trained MARINE ENGINEER, possessing A.M.I.M.E. Degree or equivalent. Age 30 to 35, preferably single. Candidates should have had Sea and Dockyard Experience and hold some position of authority. Starting rate of pay £E480-540-600 per annum, according to age and qualifications (£E1 equals £1 0s. 6d.). Progressive and pensionable post if retained. Liberal leave. Strict medical examination.—Apply by letter, giving full particulars of education, training and experience, to ADVISORY ENGINEER, Sudan Government London Office, Wellington House, Buckingham Gate, S.W. 1, marking envelope "Asst. Dockyard Engineer." 8508

Ssituations open

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, BOILER INSPECTOR for Large Company operating Collieries, Iron and Steel Works, &c.—Address, giving full particulars of qualifications, experience, salary required, 8509, The Engineer Office. 8509 A

WANTED, CENTRIFUGAL and TURBINE PUMP DESIGNER and DRAUGHTSMAN, capable of producing efficient High and Low-lift Pumps at competitive prices with modern equipment. State experience and salary required.—Address, 8448, The Engineer Office. 8448 A

WANTED, CHIEF ENGINEER for Iron and Steel Works. Must be conversant with up-to-date practice and thoroughly experienced in reconstruction work.—Address applications, which will be treated in confidence, P4546, The Engineer Office. P4546 A

WANTED, MECHANICAL ENGINEER for China, with good general and technical experience of Oil Engines, Motor Transport, Steam Plant, Industrial Machinery and Modern Machine Shop Practice; must be tactful and have had experience of organisation and management.—Reply, stating age and salary required, to Box D.L., c.o. Davies, 95, Bishopsgate, E.C. 2. 8529 A

PRODUCTION ENGINEER, for Important Engineering Company engaged on highest grade product (London district); must have first-class qualifications and wide experience in a similar capacity. Only men of ability need apply.—Address, stating age, qualifications, full details of experience (with names of previous employers in date order), and salary required, 8507, The Engineer Office. 8507 A

PRIVATE SECRETARY (MAN) REQUIRED by Consulting Engineers in Westminster for four or five months' visit to the East, but with prospects of continued employment on return home if found competent. Good general education and rapid shorthand, and, if possible, some experience of a similar nature, including travelling abroad.—Address, stating age, experience, salary required, and giving two references, 8500, The Engineer Office. 8500 A

RATEFIXER and PROCESS MAN REQUIRED for West of England; must be man of all-round experience on high-class work.—Address, stating age, qualifications and salary required, 8511, The Engineer Office. 8511 A

RATEFIXER, Good Man, REQUIRED, Able to make time studies of Machining and Fitting Operations; must be first-class Mechanic. State full experience, age, salary.—Address, 8486, The Engineer Office. 8486 A

REPRESENTATIVES Calling upon Waterworks Undertakings WANTED to market speciality on a commission basis; must be good salesmen and should possess car.—Address, with particulars, P4547, The Engineer Office. P4547 A

SALESMAN of Good Personality and Appearance REQUIRED to represent a well-known firm of Valve and Fitting Manufacturers in a London district. Knowledge and experience of Heating and Plumbing Trades in the sale of Pipe, Valves and Fittings essential.—Write, stating age, salary required and experience in detail, to "S. P.," c.o. J. W. Vickers and Co., Ltd., 24, Austin Friars, E.C. 2. 8480 A

SITUATIONS OPEN (continued)

THOROUGHLY COMPETENT STEEL WORKS ENGINEER WANTED to join staff of large Furnace Company; experienced in Modern Steel Works, Furnace and Rolling Mill Practice; must have sound technical and practical training, with commercial experience and wide connection with leading steel works. Preference given to applicant who has had full technical and commercial control of a similar department. To receive consideration, give fullest particulars.—Address, 8512, The Engineer Office. 8512 A

TRAINED ELECTRICAL and MECHANICAL ENGINEER, with experience, REQUIRED for Malaya by old-established City Firm; some commercial experience essential; must be well educated, with personality and appearance; unmarried preferred. Age 27 to 30, salary about £800 per annum. Only first-class men need apply.—Address, 8535, The Engineer Office. 8535 A

WORKS MANAGER, Capable Organiser with Modern Shop experience, able to improve methods and increase production.—Address, P4550, The Engineer Office. P4550 A

WANTED, Experienced RAILWAY CARRIAGE and WAGON DRAUGHTSMEN.—Apply by letter, giving particulars of experience and salary required, the BIRMINGHAM RAILWAY CARRIAGE AND WAGON CO., Ltd., Smethwick. 8499 A

WANTED IMMEDIATELY, North-East Coast, Durham, General Engineering DRAUGHTSMAN with Machine Design Experience; experience in Plant Installation and Building an advantage.—Reply by letter in first instance, stating age, salary required and particulars of previous employment.—Address, P4535, The Engineer Office. P4535 A

WANTED, SEVERAL MECHANICAL DRAUGHTSMEN for London district; accustomed to high-class General Engineering. Only good men need apply.—Address, stating age, experience, wage, &c., 8530, The Engineer Office. 8530 A

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For continuation of Small Advertisements see page 4.

A Seven-Day Journal

Power from the Desert.

PARTICULARS of a curious and interesting scheme of obtaining power from the Western Desert were received from Cairo this week. The scheme is described in a report issued by the Desert Survey Department. During the war a reconnaissance officer working among the Senussis reported the discovery of a vast depression in the desert, the bottom of which is about 130ft. below sea level. Subsequent investigation confirmed the existence of the depression, and showed that it has an area of about 4½ million acres—or about half the present habitable area of Egypt—and that in parts it is as much as 440ft. below the sea level. Various schemes were considered for turning the depression to good account, including one for the creation of a vast inland harbour, another for the drainage of the Delta, and a third for the reclamation of marsh lands. The scheme finally favoured by the Department is to cut a conduit from the Mediterranean to the depression and to generate electrical power from the inflowing water. Natural evaporation would be relied upon to take off the water. From the lake created, 4,000,000 cubic feet of water would, it is estimated, be evaporated daily. The fall obtainable would be about 120ft. The report estimates that a maximum of 300,000 horse-power, or 170,000 on the most conservative basis, could be generated from the plant installed at the lake. This power, it is stated, would be sufficient to satisfy all the needs of Lower Egypt now and for the next hundred years. The scheme, it is estimated, would cost about £15,000,000 to carry out, and £1,000,000 annually for upkeep expenses. The revenue from it would be over £2,000,000 annually. Important and valuable climatic modifications, it is pointed out, would also probably attend the creation of a lake in the midst of what is now an arid desert.

Institution of Naval Architects.

A COMPLIMENTARY dinner was given by the Council and members of the Institution of Naval Architects to their late President, his Grace the Duke of Northumberland, K.G., and the honorary treasurer, Sir Charles Ellis, at the Whitehall Rooms, Northumberland-avenue, London, on Tuesday last, May 15th. Presentations were made in recognition of the great services rendered to the Institution by the two gentlemen in whose honour the dinner was held. A striking picture of H.M.S. "Hood" at full speed, by Mr. Bernard A. Gribble, the well-known marine painter, was presented to the Duke of Northumberland, and a handsome silver gilt centre piece to Sir Charles Ellis. In the unavoidable absence of Admiral of the Fleet Lord Wester Wemyss, President of the Institution, Sir John Biles, Hon. Vice-president, took the chair and made the presentation of the picture of H.M.S. "Hood" to the Duke of Northumberland, while Mr. Francis Henderson, hon. treasurer of the Institution, presented the centre piece to Sir Charles Ellis.

Sir W. G. Armstrong, Whitworth and Co , Ltd

SPEAKING at the annual general meeting of Sir W. G. Armstrong, Whitworth and Co., Ltd., held in London on Friday last, May 11th, the chairman, Lord Southborough, stated that the building of the battleship "Nelson" had involved the company in a substantial loss. Discussions in connection with that loss were, he said, being carried on with certain Government Departments and he was hopeful that the firm's claims would meet with consideration from the Government. Lord Southborough also stated that the firm's Scotswood works were being developed, and that a sum of about £250,000 was being spent on new buildings, plant and equipment. The Tyne Iron Shipbuilding yard, he added, had been purchased, and would be used as an auxiliary to the Walker yard. The machine tool business at Openshaw was to be developed in conjunction with and in the name of Craven Brothers (Manchester), Ltd., a company in which Messrs. Armstrong now held the majority of the shares. As the lines on which the company was to operate in the future had become clearly defined, the board of directors felt that the time had come for the appointment of a permanent chairman. The post, involving the supreme direction of the affairs of the company, had been offered to and had been accepted by the Earl of Verulam.

The U.S. Cruiser Programme.

ALTHOUGH the American naval programme, in its revised form, has now been passed by both Houses of Congress, funds for beginning work on the ships have still to be voted. The approximate expenditure involved is £54,800,000, representing the cost of fifteen cruisers, one aircraft carrier, and two special vessels for the salvage of submarines. The Bill, as approved by Congress, authorises the President to undertake the construction of all these ships before July 1st, 1931. Five cruisers are to be laid down in each of the financial years 1929, 1930 and 1931, the cost not to exceed £3,400,000 each. The aircraft carrier is to be begun before June 30th, 1930, her cost being limited to £3,800,000. All the cruisers are to be of the largest and most powerful type permissible under the Washington Treaty, and will therefore have a standard displacement of 10,000 tons and an 8in. gun armament. The displacement of the aircraft carrier was originally fixed at about 13,500 tons, but in view of the financial limit now specified, together with the high cost of construction in the United States, the size of the vessel may have to be curtailed. American shipbuilding interests are disconcerted by an amendment to the Bill, stipulating that eight of the cruisers shall be constructed in Government yards. The Senate, however, has adopted a further amendment which excepts from this rule "such material or parts thereof as the Secretary of the Navy may find procurable by contract or purchase at an appreciable saving in cost to the Government." The debate on the Bill has been so protracted that it is now doubtful whether Congress will find time to vote money for starting work on any of the vessels before it adjourns.

A Greenock Shipyard to Close Down.

IT was officially intimated on Saturday last, May 12th, that owing to insufficient new work the directors of Harland and Wolff, Ltd., had decided to close down the firm's shipyard at Greenock. The members of the staff will terminate their engagements at the end of next month, but it is expected that it will be possible to reopen the yard when shipbuilding prospects further improve. The output from the yard has not been very large for several years past, and although some such measure was perhaps expected, the decision to close will, nevertheless, be a disappointment to the town of Greenock. It will be recalled that after purchasing the old-established shipyard and engine works of Caird and Co. in 1916, Harland and Wolff carried out a large programme of extensions. The old West Harbour was filled in, the West Kirk was removed and reconstructed on a new site, and a considerable amount of property was taken down to make room for the extended yard. Unfortunately, it has not been possible to utilise the plant to its full capacity. No engines have been constructed since Messrs. Caird's time, and the output of tonnage has not in any one year exceeded a total of about 100,000 gross tons, which was roughly the figure for 1922 when the last Caird vessel was built. This year only one ship, a 5800-ton cargo steamer for James Nourse, Ltd., of London, has been constructed. At the recent annual meeting of Harland and Wolff, Lord Kylsant stated that while some temporary economies might be necessary, he trusted that the time might be near when increased work would enable the firm to keep all its establishments running.

Safeguarding the Steel Industry.

AT a largely attended meeting held at the Albert Hall, London, on Tuesday evening of this week, the policy of the Empire Industries Association was explained by the chairman, Sir Robert Horne. Sir Robert said that the Association would not be prepared to see efficient British industries ruined by the import of goods produced in foreign countries under conditions that were not permissible in this country. He argued that the duties imposed under the Key Industries Act and the Safeguarding of Industries Act had lessened importation and had increased employment. Manufacturers had not become slack and inefficient, as opponents of the policy embodied in those two Acts had feared they would, nor had prices been raised against the home consumer. Sir Robert proceeded to refer particularly to the need for safeguarding the steel industry. It was, he said, one of the basic industries of the country, but no one could look at its statistics to-day without feeling alarm. The Government had said that the steel industry with its many ramifications could not be dealt with in isolation, but the matter could not be left in that position, for the industry was suffering neither from incompetency nor inefficiency, but solely because of foreign competition. Sir Henry Page Croft, following Sir Robert, proposed a resolution urging the Government to take immediate steps to provide adequate safeguards for the steel industry. Last year, he said, this country imported more steel than it exported, and in a very short time the industry would be entirely dominated by foreign competition. Two years of safeguarding would, he claimed, restore the industry to prosperity. Mr. George Spencer and Mr. David Bremner spoke in support of the resolution, which was carried with acclamation.

Apprenticeship in the Engineering Industries.

THE sixth report issued by the Ministry of Labour detailing the results of an inquiry into apprenticeship and training for the skilled occupations has just been issued. It covers the engineering, shipbuilding, ship-repairing and other metal industries. The seventh report, to be issued at an early date, will summarise and discuss the information in the preceding six. The sixth report, to be obtained from the Stationery Office at 7s. 6d. net, is a lengthy document, running to over 200 pages. It contains a vast amount of information concerning not only the conditions governing apprenticeship in the metal-working industries, but also the work which the apprentices are called upon to do. Many curious facts are revealed, but perhaps the most significant is the extraordinary manner in which the practice of apprenticeship varies from district to district and from trade to trade. In Scotland, for instance, 98 per cent. of the apprentices in all the trades covered by the report are shown as serving a five-year engagement. In Manchester, however—and the same figures are roughly good for the whole of Lancashire—only 2·8 per cent. of the apprentices are returned as engaged for five years, no less than 58·4 per cent. serving for seven years. In the textile engineering industry only 1·9 per cent. of the youths in training were apprentices bound by written agreement. Apprentices bound by verbal agreement numbered 68·5 per cent., the remainder, 29·6 per cent., being what the report classifies as learners. In the marine engineering industry, on the other hand, 49·5 per cent. of the youths were apprentices bound by written agreement and 49·8 per cent. were verbally bound apprentices, only 0·7 per cent. being learners. Of the apprentices covered by the whole of the returns, 5·7 per cent. paid premiums. Of these premium apprentices, 93 per cent. paid £5 or less. In the Mersey and Barrow district 35·1 per cent. of the apprentices paid premiums, whereas in Manchester and the rest of Lancashire and Chester the premium apprentices were not more than 2 per cent. of the total. The figures in the report are derived from returns received in 1925 from 1573 firms, employing 500,527 male workers, of whom 58,647 were apprentices or learners.

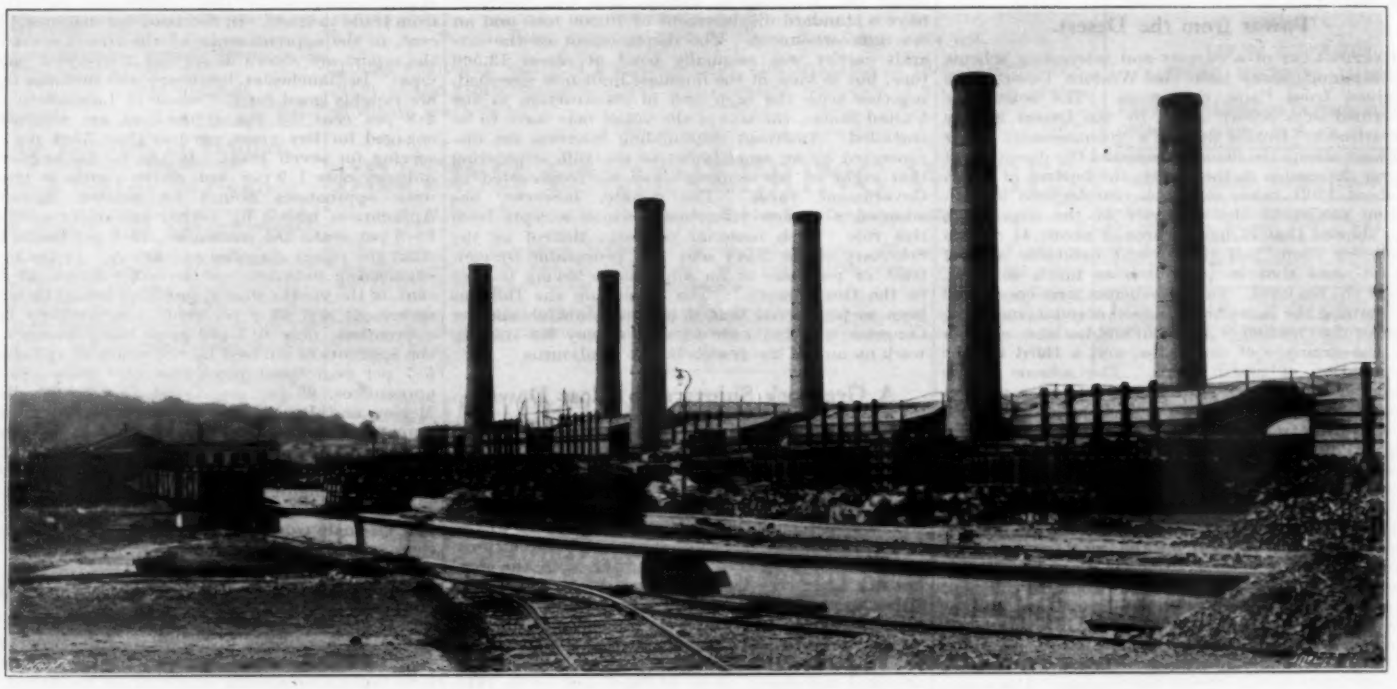
New Shipbuilding Orders and Conversions.

THE newly formed firm of Workman, Clark (1928), Ltd., which recently received its first order for a small vessel from the Belfast Harbour Authorities, is to build a twin-screw motor vessel for Alfred Holt and Co. The new ship will be generally similar to the "Idomineus" and "Orestes," which were built by the old firm for the same owners in 1926. There is a marked revival of interest in the possibilities of increased economy in propulsion, which are afforded by the combined reciprocating steam engine and the exhaust turbine working on a single shaft with flexible gearing on the Bauer-Wach principle. In this connection we understand that the Clan Line, Ltd., will convert six of its recently constructed steamers to this form of drive. Three ships will be so fitted out by William Beardmore and Co., Ltd., at Dalmuir, and a further three at Hamburg by the Vulcan Werke. All the steamers to be converted have a deadweight-carrying capacity of about 8850 tons, and their present designed speed is about 11 to 12 knots. They were built between 1921 and 1923 by the Ayrshire Dockyard Company, Ltd., at Irvine, and were engined by Dunsmuir and Jackson, Ltd., of Glasgow. The Blythswood Shipbuilding Company, Ltd., of Scotstoun, is to construct for the Prince Line, Ltd., two twin-screw motor vessels for that company's New York–South America service. The new ships will be propelled by Doxford opposed piston motors, which will be built by Richardsons, Westgarth and Co., Ltd., at West Hartlepool. At Dumbarton William Denny and Brothers, Ltd., have recently carried out speed trials on the motor vessel "Daga," in which they have installed Denny-Sulzer engines. Originally, this ship was the "Malia," and was propelled by two Cammellaird-Fullagar engines. One of these engines was built for the all-welded coaster "Fullagar," and being found to be too powerful for the hull was taken out and installed along with a similar set in the "Malia." On the trial trip a speed of 10¾ knots was obtained. Later two 1000 S.H.P. units of the same design which were originally designed for the ship were installed. The vessel, which formerly belonged to T. and J. Brocklebank, Ltd., of Liverpool, has now passed into the hands of the British and Burmese Steam Navigation Company, Ltd., Glasgow.

Pulverised Fuel for a Cargo Liner.

IN a paper read at the summer meetings of the Institution of Naval Architects, held at Cambridge last year—see THE ENGINEER of July 15th, 1927—Engineer-Captain J. C. Brand described in some detail the progress which had then been made by Clarke, Chapman and Co., Ltd., of Gateshead, with the firing of Scotch marine boilers by means of pulverised coal. During recent months the Woodeson pulverised fuel burner has so been developed that it can now be readily applied to existing marine boilers. The burner casing does not project more than about 2ft. from the front of the boiler, and the length of flame can, we understand, be controlled so as not to exceed 3ft. or 4ft. We are able to state that, with a view to testing the new system under actual sea-going conditions, arrangements have been made to equip with plant of this type one of the single-ended coal-fired boilers on a 10,500-ton twin-screw cargo liner belonging to the Blue Star Line (1920), Ltd. The particular steamer has yet to be decided upon. The burner will be carefully tested throughout a lengthy voyage, and if successful the two other double-ended boilers on the ship will then be converted for pulverised fuel working, the single-ended boiler being retained for hand firing, to give the necessary flexibility in steam raising either at very slow speeds or during continued manœuvring periods.

STONEWARE PIPE WORKS OF DOULTON AND CO., LTD., AT ERITH



PIPE-BURNING KILNS AND DELIVERY SIDINGS

The Erith Stoneware Pipe Works.

ERITH, on the Kent side of the Thames, was noted, about a generation ago, for the importation of coal and the export of ballast for the sailing ships which brought in the coal. Now, with steamers and water ballast the sand pits have ceased business, but the coal still comes in and—a reversal of process—earthy material, in the form of clay, arrives from another part of the coast and is manufactured into an exportable commodity. This happens at the new works of Doulton and Co., Ltd., where there has just been started one of the most modern of stoneware pipe making plants embodying every possible labour-saving device. It is described and illustrated herewith and in our Supplement.

THE SITE.

To the men who knew Erith of forty years or so ago it seems almost incredible that what might be described as a heavy industry could be built up on the old marshes between the Corinthian Club and the Oil Works, but it must be remembered that in the interval a huge amount of spoil has been transported there during the construction of the tube railways and has brought up the level of the land from the waterlogged marsh to that of the embankment. Of this land Doulton's have secured some 25 acres, and thereon have built the factory, one side of which is illustrated in the picture above. And this factory is noteworthy for several reasons. First, it has been laid out regardless of any site restriction; secondly, it has been organised on the experience of the owners, which goes back for over eighty years at the old Lambeth works; and thirdly, the conditions of working in the factory are such that the "hands"—both men and girls—go away home at the end of a day's work looking as spick and span as those from a City office.

We imagine that the success of this company in such pioneering work as the sewering of foreign cities was largely dependent upon the quality of its product, but recent developments abroad have made a serious inroad on England's export business in this direction, and it is to be hoped that the inauguration of the works described below will help to regain her prestige in this direction.

The Erith pipe works have the merit of an ideally flat situation, a river frontage, at which fair-sized steamers can tie up, a railway connection, and a good supply of labour. The site certainly needed piling for the heavier structures and some 600 reinforced concrete piles were sunk for that purpose by Messrs. Christiani and Nielsen; but the majority of the buildings are of single-storey height and comparatively light on their foundations.

Continuing the same general theme it seems appropriate here to mention the fact that the company is building a number of semi-detached cottages on the hillside behind the works for the more important workpeople, and we were impressed, during our casual tour round this part of the company's property, by the cordial relations which exist between the tenants of the cottages and the officials of the firm.

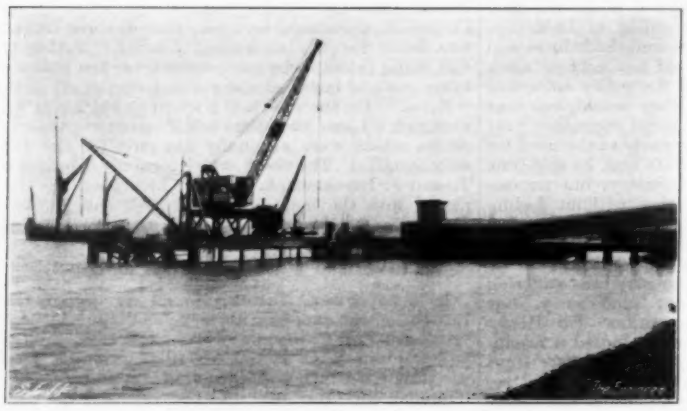


FIG. 1—JETTY AND UNLOADING CRANE

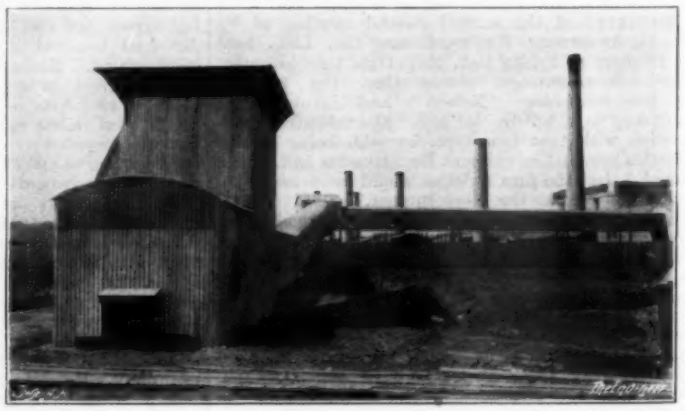


FIG. 2—MAIN MATERIALS CONVEYOR

HANDLING RAW MATERIALS.

Now, coming to the manufacture of stoneware pipes; they are made of a mixture of clay, sand and "grog," while a considerable amount of coal is required for power and heating purposes in the process of manufacture. These raw materials are congregated near the river front. The clay comes, by chartered steamer, from the company's own pits in Poole Harbour, Dorset, the sand from pits in Kent, and the coal from the North, also by water. The "grog"—which is the technical name for broken pottery—is collected from wherever it may be available, and it is noteworthy that the wastage of burnt ware in this factory is insufficient to keep pace with the demand for new stuff, so that the greater proportion of it has to be bought outside.

All the materials coming by water are handled at the jetty shown in Fig. 1, which is equipped with a crane by Butters Bros. and Co. This crane, which, like all the rest of the machinery on the site, is electrically operated by current produced in the works power-house, is of 4 tons capacity and has an outreach of 55ft. It can travel along the jetty, and for that purpose collects its current from an underground conduit, so that there are no exposed live wires. In normal working, however, the jib is of sufficient length to command the crane's work without recourse to the travelling movement. It is supported on a framework having an 8ft. 6in. portal with 23ft. between the running rails, and the operator has a good view down into the hold of a vessel lying alongside. The crane is equipped with a Barnard grab, which is furnished with long tines when clay is being handled, though they can be easily removed for lifting sand or coal.

The clay, coal and sand unloaded by the crane are all taken up to the works by one conveyor, the loading hopper of which is visible in Fig. 1, while it is more prominently shown in Fig. 2. In view of the fact that such a diversity of materials has to be handled, and the tenacious nature of the clay, which tends to stick to a conveyor belt, steel band conveyors have been adopted for this service, as they can be effectively scraped clean without damage. These conveyors have been supplied by the Steel Band Conveyor and Engineering Company, Ltd., and are 24in. wide.

The coal and sand can, obviously, be easily loaded on to the conveyor through a hopper, but the clay offers some difficulty, as it tends to stall in a hopper on account of its tenacious and plastic nature. This difficulty has, however, been overcome by the hopper arrangement, shown in Fig. II. of our Supplement, which was devised by Mr. C. E. Morris, of the Doulton Company, in conjunction

with the Steel Band Conveyor Company. The essential features of the arrangement comprise two shoots, which can be seen in the upper part of Fig. II. That on the right, on to which the clay is dumped by the grab, is pivoted at its top edge, while the left-hand shoot is pivoted at the bottom. The angular attitude of both shoots can be adjusted by means of wire ropes and winches, one of which can be seen on the extreme right of the illustration. In this way the shoots can be so sloped that they suit the natural angle of slip of the clay, and it is fed steadily forward towards the conveyor. The shoots, by the way, are 6ft. wide and are built up of ¼in. steel plate.

The material coming down the shoots is not dumped directly on to the conveyor band, but is first dropped on to what might be described as a long star wheel or feeder. This feeder is driven in synchronism with the conveyor by the chain and bevel gearing which shows up so prominently in Fig. II. of our Supplement and ensures that the whole of a grab full shall not be suddenly dumped on to the band.

From the loading hopper the supplies are taken by the rising conveyor—see Fig. 2—for a distance of 157ft. to the transfer station shown in Fig. IV.—Supplement—where a turn of approximately a right angle is made. Here, it will be seen, the first conveyor runs over the top of a second band and the materials are ploughed off from one to the other down appropriate shoots. There are two shoots, as it has been found that the slope of discharge for sand and coal is not the same as that for clay if the conveyor band is to be effectively loaded, and the discharging plough can be moved to scrape off into either of the hoppers. The plough can also be removed entirely and then the conveyor discharges over the end into a hopper with an outlet commanding a roadway below, on which distributing trucks can be run.

The general practice is, however, to transfer the load from one conveyor to the other and to dump the material into stores beneath the second conveyor, which is 296ft. long. The coal is ploughed off on to a site adjacent to the boiler-house and the kilns, while the clay and sand are carried on further to covered stores. The only other bulky raw material, the "grog," is brought into the works as convenience may offer and is stored in a yard beside the mill shown in Fig. VI. of our Supplement.

In this mill the material, which may comprise "wasters" from the factory itself, any old crockery and scrap fire-brick, is crushed to ¾in. cube in a Blake-Marsden jaw crusher from which it is elevated to a grinding pan, by G. Whittaker and Co., Ltd., 9ft. in diameter. In this pan the material is ground to a fine powder and it is then raised to two overhead rotary screens furnished with wire fabric having a mesh of from 10 to 20 per inch, according to the class of work in hand. The rejects are returned to the mill, while the fine stuff is stored in two bunkers of 40 tons capacity each. The motors for driving the crusher and the mill are arranged on the floor above and are mechanically connected with their machines by belt and chain, respectively, as shown in Fig. VI. in the Supplement. The controllers of these motors are also so interconnected electrically that the crusher cannot be started until the mill is under way.

Proportioning Machine.

We now come to the stage in manufacture where it is necessary to incorporate the various ingredients in the proper proportions.

This operation is effected in a proportioning machine, the inlet hoppers of which can be seen in the floor in Fig. 5. There are three separate hoppers. The one in the foreground is supplied with clay by side-tipping wagons, as shown on the left. The next hopper receives sand, also by truck, and the third ground grog by shoots from the overhead bunkers. The bottom of the hoppers is formed by a slow-moving metallic band much after the fashion of a travelling grate stoker, which steadily drags the several materials forward under the bulkheads of the hoppers. These bulkheads can be adjusted as to height above the travelling band so as to regulate the relative proportions of the ingredients, and at the outlet side of the clay hopper there is a rotary cutter to chew up any large masses and ensure a continuous passage of the clay. At the delivery end of the band there is also a scratcher to deliver the mixed materials on to an elevating conveyor. The drive for the travelling band is by means of a belt running on stepped cone pulleys, so that the rate of delivery can be adjusted to suit the requirements of the works.

There is no doubt that the provision of this proportioning machine is largely responsible for the uniformly good quality of the ware turned out by the Doulton factory, and marks a step in advance of the old-fashioned method of supplying a mill by the barrow load, as it can be assured that, once a mixture has been settled upon and the bulkheads set appropriately, that mixture will be supplied as long as the necessary materials are provided.

The prepared mixture is taken from the proportioning machine to the mill house by a plate conveyor which rises to the second floor at an angle of about 25 deg. The drive for this conveyor is interlocked with that of the proportioning machine and the mill in such a manner that the machines can only be started in the proper sequence, and there is no fear that one may be choked by the other through premature starting.

Grinding Mill.

The material delivered by the plate conveyor is, of course, only roughly mixed together although it is in the correct proportion, and it requires considerably more manipulation before it is ready for moulding. This work is effected in the mill shown in Figs. I., III. and V. of our Supplement, which is by the Pragos Engineering Company, of London. This machine is a massive structure reaching right up through the mill house from the ground to the second floor. The main frame is formed by four cast iron columns of crescent-shaped section with horizontal bracing. At the top there is a grinding pan—see Fig. I.—9ft. in diameter, round which a pair of rolls is driven by a vertical spindle. The conveyor from the proportioning machine delivers directly into this pan. The rolls are set at different distances from the centre of the pan, so that in their rotation they work over practically the whole of its floor. The floor is partly perforated, with slits ¼in. wide by 2in. long, and partly plain. The result is that the mixture is ground on the plain parts of the floor and is then squeezed through the perforations to fall into a similar pan immediately beneath. In the second pan—see Fig. III.—the perforations are ¼in. wide by 2in. long. The plain parts of the floor of this pan are so placed that they come beneath the perforations above. This arrangement is, of course, necessary to prevent the material being squeezed straight through the second pan. In both these mills a fine spray of water is added to soften the clay.

The material from the second mill falls on to a large disc keyed on to the vertical spindle immediately

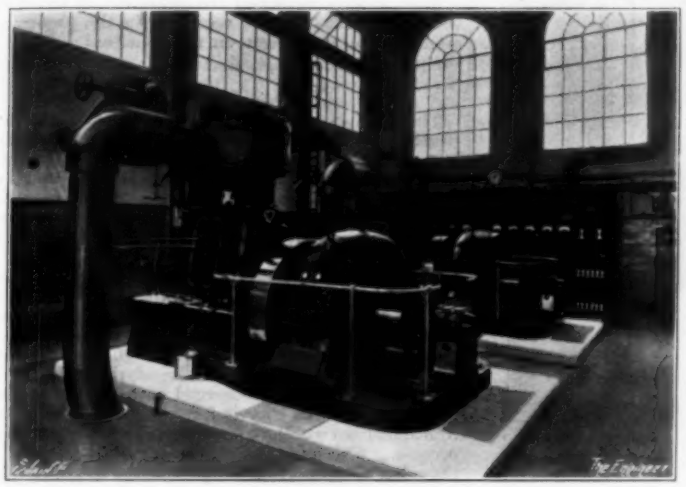


FIG. 3—THE ENGINE-HOUSE

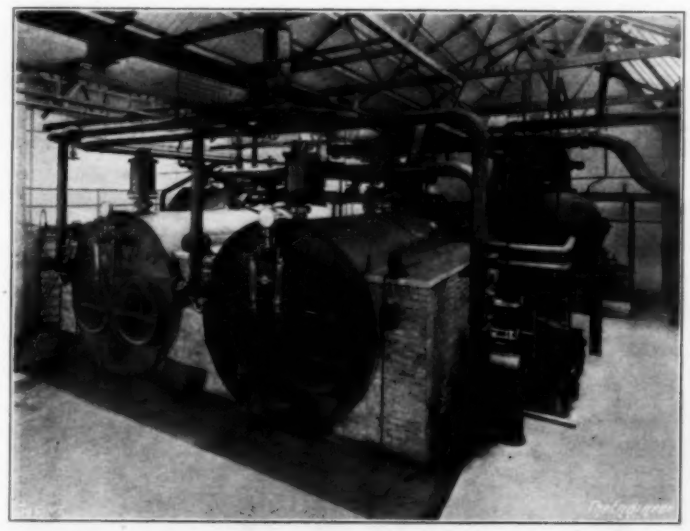


FIG. 4—THE BOILER-HOUSE

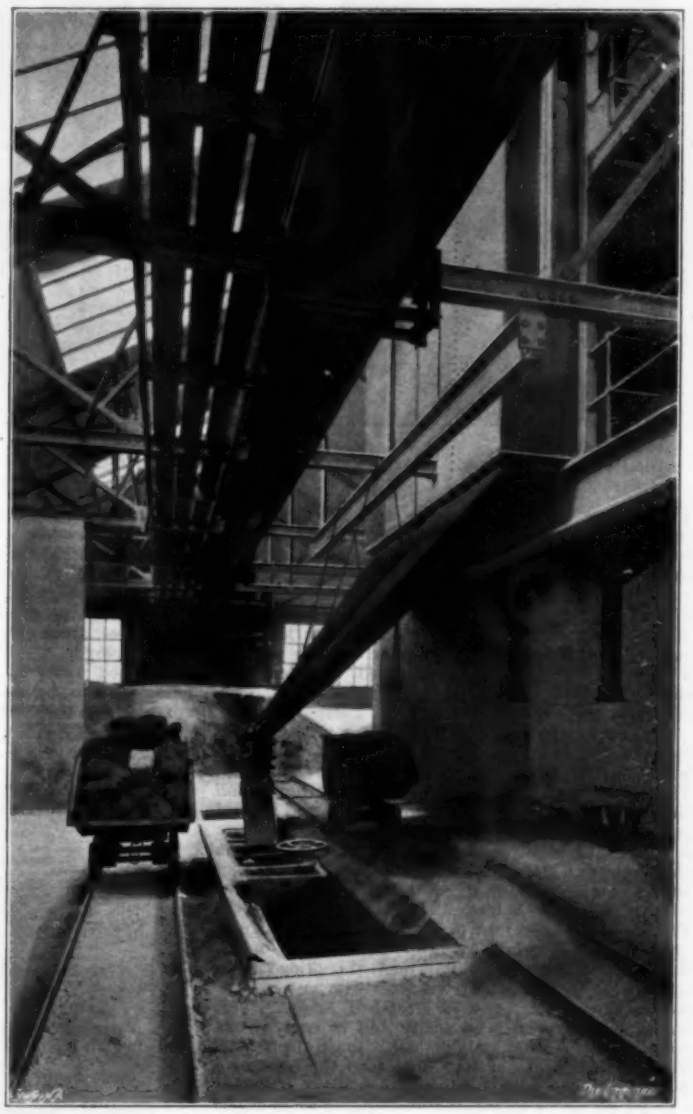


FIG. 5—THE PROPORTIONING MACHINE

below the pan. This disc incidentally provides a means for carrying the bevel gearing driving the two mills. Just below this disc there is the footstep bearing for carrying the weight of the revolving parts. The material is scraped off the disc by a plough and falls down a shoot to a fine grinding roller mill. This mill, which can be seen towards the right in Fig. III. has a pair of chilled iron rolls, 2ft. 7½in. wide by 1ft. 7½in. in diameter. The rolls are ground to a very fine surface, and run one at 150 revolutions per minute and the other at 175 revolutions per minute, so that they produce a grinding action. They are set

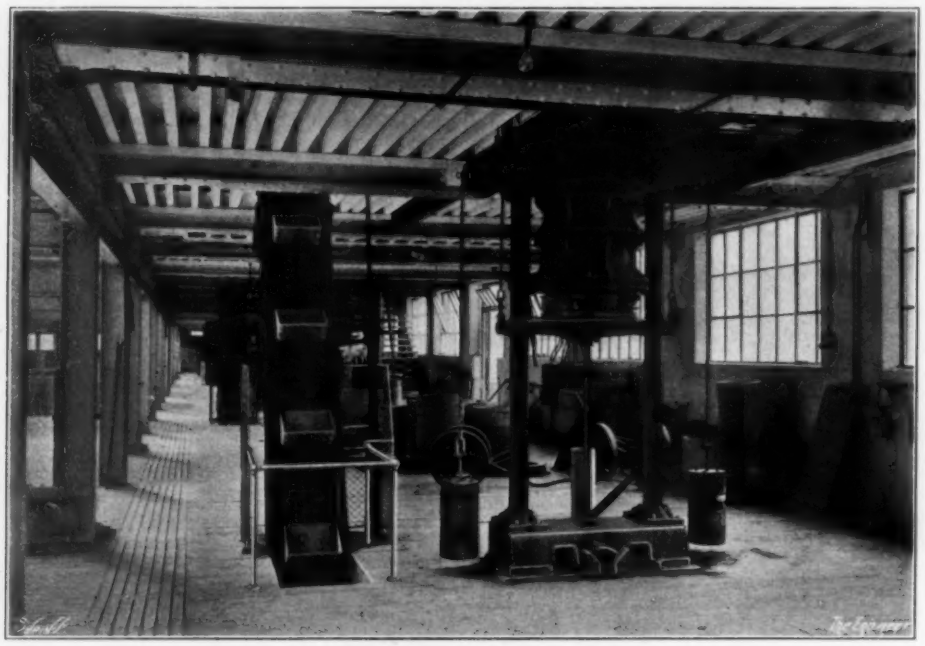


FIG. 6—PIPE-MAKING MACHINE

1 mm. apart, and in view of the damage which would be caused if any foreign matter, such as a nail, were to drop between the rolls, a breaking plate is arranged in the adjustment for the bearings to give way in case of such an accident. These plates can be replaced and the mill started again easily within 20 minutes. It is, naturally, necessary to keep the surfaces of the rolls in good order, and for this purpose a special grinding wheel is provided. The countershaft for driving this grinder can be seen beneath the ceiling in Fig. III.

The material coming from the fine grinding mill falls into a mixing machine below—see Fig. V.—which is very similar to those used in brickmaking. That is to say, it is a long cylinder within which there rotates a worm. The material is stirred up and pushed forward by this worm and is extruded through a perforated plate at the end. Outside this plate there rotates a star wheel, which slices off the material as it issues and allows it to drop into another very similar machine below. The second mixer—see Fig. V.—has a roller feed, and its outlet is a rectangular orifice, measuring 6in. by 4½in. A long slug of the finished clay is pushed out through this orifice along a table to an automatic cutter. The cutter is a simple frame with a wire stretched across. This frame is reciprocated vertically and at each stroke cuts off a section, about 8in. long, from the slug. These lumps of clay drop into the boot of a bucket elevator which delivers them to a conveyor running along the length of the moulding room at the level of the first floor. This conveyor is also a steel band, by the same makers as those at the riverside, and is 18in. wide by 440ft. between centres. The lumps of clay are delivered by the elevator on to a sloping shoot leading to the conveyor, and, in tumbling down this shoot, pass under a swinging gate, hinged at the top, which prevents them falling off the sides of the conveyor. It will, of course, be understood that the steel band conveyor is flat, and that without the gate there might be a liability for the lumps to arrive on the belt so near to the edge as to tumble off on to the floor. Along the length of this conveyor there are seven discharging ploughs, adjacent to the machines which they are intended to serve. The clay is ploughed off the conveyor on to the floor, and is stacked in a handy manner by a labourer. In this connection we learned that, provided the stack of clay is sheeted over fairly well it will remain in condition for working up in the machines for several days. Before passing on from this conveyor, it may be as well to mention the fact that both its strands are put to a useful purpose. The top strand is, as just described, used to deliver lump clay to the pipe-making machines, while the return strand is used to take scrap pieces back to the grinding mill.

Having followed through the process of preparing the clay for moulding, it seems appropriate here to make a diversion in order to describe the power plant, which, incidentally, provides an important service in supplying steam for the drying of the ware made.

Power and Heating Plant.

The power plant has been planned out on a generous scale, so that it will be adequate for the service of the factory, even if the whole of the site available is developed. It comprises two Lancashire boilers—see Fig. 4—by John Thompson Ltd. They are 30ft. long by 8ft. in diameter, and are hand fired. The working pressure is 180 lb. per square inch, and the steam is superheated by about 100 deg. Fah. in Sugden superheaters, while there is a Green's economiser on the feed side. The chimney stack is 120ft. high, and natural draught is relied upon to maintain the steam pressure. Coal is delivered on to the firing floor by side-tipping trucks, handled by a Simplex petrol locomotive, from the adjacent dump served by the main conveyor.

The feed water is, almost entirely, returned condensate from the heating system that utilises the exhaust from the main engines. There are two main feed pumps by Weirs—see Fig. 4—which suck from a large cylindrical storage tank. The return condensate is fed into this tank, through a Lassen and Hjort, wood-wool packed oil filter, by a Nash centrifugal vacuum pump. This pump is capable of maintaining a vacuum of about 10in. water gauge in the return mains, and has alternative drives by electric motor and an impulse steam turbine. The discharge from the filter to the storage tank is visible, so that the attendant can easily see if the feed water is coming over really clean.

In the engine-house there are two Belliss and Morcom 250 H.P. compound engines—see Fig. 3—coupled with 175-kW G.E.C. generators producing direct-current at 220 volts. The engines are designed to give their rated output with a back pressure of 1 lb. per square inch, and in the event of the whole of the exhaust not being required for heating purposes, the balance is exhausted to atmosphere, through a loaded valve. Before being introduced to the heating system the exhaust steam is passed through a separator to extract as much of the oil it may contain as possible.

The heating system, which utilises the exhaust steam is a network of piping beneath the floor of the drying shed, and was arranged by Ashwell and Nesbit, Ltd. It comprises some 7 miles of 2in. piping, arranged in twenty bays along the length of the shed. There are two separate coils of piping in each bay, so that there are forty discharge traps in all. The steam supply main starts at 8in. in diameter and is reduced to 4in. at the distant end. The return condensate main from the traps is so looped that there is no fear, should a trap get out of order and blow steam, that its section of heating coil will rob the others of their supplies of steam. The extent of this heating system may be gauged from the fact that the drying shed measures 460ft. by 125ft., and has a considerable amount of glazing in the roof.

Now, having reviewed the provision of the clay, the power and the heat necessary in the process of manufacture, we can go on to the actual making of the pipes.

Pipe-making Machines.

There are seven pipe-making machines, by Wootton Brothers, Ltd., arranged in a row along the western side of the drying shed. They are, together, capable of making pipes of any diameter from 2in. to 24in., and from 2ft. to 3ft. long. These machines, of which one is illustrated in Fig. 6, extend through the floor above, whence they are fed with clay from the stacks alongside the long conveyor.

The machine is really very simple and comprises a vertical cylinder within which there works a coarse pitch worm. This worm is driven through gearing, a Heywood and Bridges friction clutch, and a Hans Renold chain by an electric motor of some 50 H.P. downwards, according to the size of the pipes to be made. The cylinder is charged with clay at the top by hand, and this clay is forced downwards by the rotation of the worm, to form the pipe by an extrusion process. The annular orifice for this purpose is provided by supporting a core within a larger circular opening by means of an internal spider. The clay flows freely round this spider and joins together again to form a compact mass as it issues from the annulus.

It is, however, necessary to form the socket on the pipe for its connection with its mate, and that is effected in the following manner:—Beneath the bottom of the cylinder there is a horizontal table, which is counterweighted and can slide up and down on guides. In the process of making a pipe a former, for the socket, is set in the centre of the table, and the table is raised so that the former butts close up against the annular opening. The table is locked in this position and the worm is set in motion by engaging

FIG. 7—DRYING SHED

the friction clutch. The clay is forced downward and fills the socket former and, as soon as it is seen that the clay is spewing out through the joints, the table is released and the force of the extruding clay drives it down while the cylindrical part of the pipe is formed. When a sufficient length of pipe has been extruded, the worm is stopped, a length gauge is placed on the platform, and the pipe is cut off with a wire. The pipe is then lifted off the table—it is quite strong enough to bear reasonable handling—and is slipped on to a mandrel, which is greased to prevent the clay sticking. With convenient tools, the fins left at the socket end are turned off and the serrations

for the keying of the jointing material are made at each end. The pipe is taken off the mandrel, stamped and carried away to the drying shed. The scrap stuff coming from the finishing machine is taken upstairs by the conveyor seen on the left in Fig. 6, and is returned to the mill by the long band conveyor, as already mentioned.

Besides plain straight pipes, there are, of course various complicated forms required in drainage systems, and many of them are produced by hand moulding or a combination of machine and hand work; but the process of producing a simple bend is both simple and interesting. A pipe machine is set up, as already described, and the socket end of the piece is formed as usual, but as soon as the table is released it is pulled downward quickly and a man grasps the free end of the pipe in his arms. Then, as it continues to be extruded, he pulls it sideways, and, by judgment, produces the required bend. The pipe is then put in a template and adjusted, if necessary, to get the correct form, and goes on through the remaining processes as usual; but from what we saw it seems seldom necessary to make much adjustment after the operator has made the first bend.

In the making of the larger pipes men are generally employed at the machines, but the smaller sizes are made by girls, and it is rather surprising to see the dexterous way in which they handle comparatively heavy green pipes without damaging them and without getting their clothes soiled. The pipes are carried from the machines to the drying floors—see Fig. 7—in V-shaped wooden troughs, that remind one very much of the butcher's boy's of years ago, and are stood on end to dry. On this floor they are inspected and any accidental roughness trimmed off, and they are occasionally turned upside down. An extensive system of portable inspection lamps has been installed for these purposes, and one of the extendible leads can be seen hanging in the roof in Fig. 7.

After standing in the drying shed for some days, the ware becomes "white hard," that is to say, most of the contained moisture has been driven off, and it is ready to go to the kilns for firing.

KILNS.

There are fourteen kilns at Erith, each capable of holding from 40 to 50 tons of ware, arranged in two parallel rows just outside the drying shed. These kilns are plainly seen in the view at the head of this article. There is, it will be seen, a stack, 70ft. high, for each pair of kilns. These kilns are rectangular in form and are held together by heavy buckstaves and tie rods. Their design is the result of the long experience of the owners in their other works The fireplaces are arranged along both the outside side walls and the products of combustion go up flues in the walls to the top of the kiln. They then go downward through the mass of ware stacked within, through the perforated fire-brick floor, and by a system of underground flues to the stack.

The firing process has to be carried out very carefully in the early stages, as the ware is comparatively tender, and the fires are started up gradually. Then when the full temperature has been attained, salt is sprinkled on the fires to produce the fumes necessary to glaze the ware, and, finally, the fires are damped to allow the kiln and its contents to cool down again slowly. A cycle of operations of a kiln, from setting the unburned ware to taking out the finished product varies from twelve to twenty-one days, according to the weight of the stuff being handled. The "setting" or filling of the kiln also requires considerable skill, as the ware shrinks very considerably during firing, as much as about 1in. in a foot, so that although everything may be packed in nice and tightly at the beginning, it all gets slack when the temperature is raised and the various pieces give no mutual support. In this connection accurate manufacture also plays an important part, as if all the pieces stand really square, there is much less liability for a collapse.

For some purposes customers require that pipes shall be tested hydraulically, and for that purpose Messrs. Doulton have installed some machines in which pipes can be tested rapidly to a pressure of 20 lb. per square inch; while there is also a department for furnishing the pipes with the Stanford system of jointing, which is a mixture of sulphur, tar and sand poured hot into accurately machined moulds.

In the foregoing account we have not given details of the buildings, which include a block of offices, a canteen, &c., as they are what might be described as a standard engineering job. Mr. Percival M. Fraser acted as architect.

It seems proper to point out that it was only through the courtesy and forebearance of the directorate of Messrs. Doulton that we were enabled to obtain the intimate experience necessary for the preparation of this article; while Mr. C. E. Morris, the general manager of the company's pipe works, who was responsible for the lay-out and equipment of the factory, Mr. E. H. Buck, the works manager, and Mr. C. F. Crofts, the works engineer, were most helpful in explaining the processes.

THE Public Works Department, New Zealand, is calling for tenders to be presented by July 10th for 50 kV switchgear and steel work for Arapuni power scheme.

Iron and Steel Institute.

No. II.*

THE spring meetings of the Iron and Steel Institute were resumed on Friday morning, May 4th, the President, Mr. Benjamin Talbot, in the chair.

It was announced that grants from the Carnegie Research Fund of the Institute had been awarded to Mr. Henry Temel, Kladno, Czechoslovakia; Mr. J. Vietórisz, Budapest; Mr. David Binnie, of the Royal Technical College, Glasgow; and Mr. B. S. Smith, of Sheffield University.

THE HETEROGENEITY OF STEEL INGOTS.

The second report of the Institute's Committee on the Heterogeneity of Steel Ingots was then presented by Dr. W. H. Hatfield (the chairman of the Committee). The Committee, he said, felt that with the publication of this report (the first report was published two years ago) it had now presented the results of a very systematic and careful study of the various general types of ingots, which study was really necessary in order to put on record the state of the art to date. The ingots studied and reported on were representative of good practice, and were not selected; they represented really good workmanship from the standpoint of the ingot maker. After emphasising that, in no cases, were they superior ingots which had been obtained as a matter of luck in the course of manufacture, he added that the Committee had learned a lot in the course of the investigation, and, as a result, was now much more modest about its ability to explain the various phenomena than it was before work began.

The work is confined to a consideration of further types of carbon steel ingots, and to several examples of alloy steel ingots. Consideration is also given to the subject of ingot moulds. Scientific investigations are in hand with a view to the elucidation of matters arising out of the first general research. The whole of the work has been made possible through the generosity of the firms with which some of the members are associated, in supplying data, and in facilitating and financing a most costly form of investigation, whilst for the last-mentioned investigations the Iron and Steel Institute is providing the necessary funds.

The report is divided into the following sections:—

Section I.—Introduction.
Section II.—Ingot moulds.
Section III.—Certain features of steel manufacture which may influence heterogeneity.
Section IV.—A study of nickel, nickel-chromium, and nickel-chromium-molybdenum steel ingots.
Section V.—A study of carbon steels other than "killed."
Section VI.—An interim report on the researches at Sheffield University and Glasgow Royal Technical College.
Section VII.—Bibliography, brought up to date.

The first report, issued by the Committee in May, 1926, dealt with carbon steel ingots of various sizes, the steel having been so refined that gases given off during the freezing of the ingot did not produce blow-holes—*i.e.*, all the steel was of the "killed" type, and, consequently, the ingots were of the sound type. The researches of the Committee showed, however, that all the ingots, although representing good normal production, disclosed definite heterogeneity as regards the distribution of the carbon, sulphur, and phosphorus, and, further, that the degree of heterogeneity increased with increase in the mass of the ingot. It was suggested that these variations in composition were due to the manner in which the liquid steel solidified, and whilst Section IV. of the first report was devoted to a consideration of the influence of the various factors involved, and to a tentative discussion of certain theories in explanation of the observed facts, it was realised that much research was necessary before any attempt could be made to give a complete picture of the mechanism of freezing. In certain directions the Committee has since been able to provide for the execution of several much-needed investigations. Until this work is more advanced, the Committee proposes to abstain from a further theoretical dissertation upon the results, and this second report will be confined, as far as possible, to a statement of the essential facts determined. Where explanations of isolated phenomena are discussed, the object is simply to encourage useful discussion. As indicative of the difficulties of arriving at a complete understanding of the general problem, attention may be drawn to the experimental difficulty of determining the temperature gradients existing within the steel and the mould during the actual freezing, and, incidentally, to the difficulty of obtaining the necessary data to enable the thickness of the advancing wall of frozen steel to be plotted against time. The study of any movement of the liquid steel in the form of convection currents is also difficult. Such problems are, however, receiving attention.

The design of the mould is of great influence in affecting the characteristic features of the ingot cast in it. In Section II., therefore, particulars of many of the moulds used for producing the ingots studied are presented, and some consideration in detail is given to the manner in which the mould affects the freezing of the ingot. Here, again, is a general problem which does not permit of any attempt at final statement until much more data have been obtained.

The Committee, having now under consideration various types of ingots produced by different processes, has felt it to be desirable that certain metallurgical considerations should be discussed, and Section III. is therefore devoted to that purpose. It is shown how the available resources of raw material influence the character of the process and product, and to what extent technical control is limited by the degree of scientific achievement.

Section IV. contains valuable data derived from the study of further ingots. The first report dealt with carbon steel ingots produced from fully killed steel, and an account is now given of alloy steel ingots produced from fully killed steel containing nickel, nickel and chromium, and nickel, chromium, and molybdenum; whilst in one case the distribution of a small quantity of copper present in the ingot is studied. These steels, as is generally known, are employed where enhanced mechanical characteristics are necessary to withstand the high stresses to which they are subjected in their final form. Incidentally, the temperatures permissible in the hot-working of such not so readily weldable steels, do not permit of raising them to welding heats, and it is therefore imperative that the ingot material shall be free from cavity of any kind. The ingots studied indicate that a high technical standard has been attained in the production of such material. A refractory-lined feeder head is invariably used for preventing a shrinkage cavity within the ingot proper, with the further effect, in conjunction with the design of mould, of causing the major segregates to collect in the feeder portion of the ingot, which is discarded. The data presented will enable the degree of segregation of the special elements to be judged, and also, in some measure, their effect as regards the segregation of the normal elements.

In Section V. the Committee presents data derived from several ingots representative of the great tonnages of mild steel produced. Such steel is manufactured in far greater quantity than the solid steel, both carbon and alloy, hitherto considered. Where killed steel is made for the production of forgings and other products from which onerous service is expected, the large discard from the top of the ingots results in a very materially enhanced cost of the product. In the type of material discussed in this section, the yield of finished product is much higher, thus facilitating the economic object in view of providing a large tonnage of cheap material for general purposes. Incidentally, this material is usually fairly low in carbon, and the rolling temperatures are high, and these factors result in a material satisfactory for the purposes intended, since minor cavities may weld up in the manipulative processes. Nevertheless, a comparative study of ingots of such material is essential for a proper comprehension of the whole problem of ingot production. The study of the effect of gases given off during freezing also becomes possible, with very instructive results.

In Section VI. will be found a statement reporting progress of the researches undertaken on behalf of the Committee. At Sheffield University, Professor Desch, F.R.S., has made himself responsible for work upon the viscosity and density of molten steels, whilst at the Glasgow Royal Technical College, Professor Andrew has undertaken a study of the liquidus and solidus of the steels under consideration, together with a study of the formation and nature of the sulphides in commercial steels.

In Section VII. the Committee is able, through the assistance of Mr. Lloyd and his staff, to present a summary of literature published since the bibliography in the last report was compiled.

Dr. Walter Rosenhain, in congratulating the Committee upon having presented a large mass of facts, said that the establishment of those facts was the result of a very large amount of work of an expensive and difficult character, which he ventured to suggest no one but a Committee fortunate enough to secure the free co-operation of a large number of steel firms could have produced. Whilst he was most ready to accept the assurance that to the best of the Committee's knowledge and belief the ingots were representative of good practice, it must be borne in mind that neither the Committee nor anyone else could possibly say to what degree of accuracy they were really representative, *i.e.*, how uniform, from ingot to ingot, was the distribution of the impurities. No doubt he would be told that the collective wisdom and experience of the members of the Committee enabled them to say that the ingots were representative; they might be satisfied about that, but when it came to a matter of data upon which ultimately, he hoped, scientific deductions were to be based, more was really needed. Perhaps the Committee might be able to examine sections of, say, half a-dozen of a few classes of ingots, all of which were made under the same conditions, and ascertain exactly how nearly alike those half-a-dozen ingots were. The fundamental facts in regard to the distribution of impurities would then be known, and it would be possible to say what effects were accidental, *i.e.*, due to conditions and factors which metallurgists either did not know or were not able to control. It appeared to him that there were two facts which stood out as generalisations to be drawn from the report. One was the limited extent to which segregation occurred in regard to what might be called the metallic elements, *i.e.*, manganese, nickel and chromium. That was perhaps not surprising; the atoms of those elements were so similar to the atoms of iron itself that the forces which separated them must be much smaller than in the case of the metalloids. Nevertheless, the ascertainment of that fact was important and valuable. The second was the marked influence of the liberation of gas during the soldification of an ingot upon the arrangement of the segregates. With regard to the illustrations in the report, Dr. Rosenhain said that he had seen the originals and was very sorry that the reproductions did not do the faintest justice to those very beautiful pieces of work, and he suggested that it was worth while considering whether it would not be possible to reproduce them on a more adequate scale. In making suggestions for future research by the Committee, he referred to ingots which, when rolled, were not completely solid internally, and said that, when an ingot of that kind was afterwards cut and etched, a white patch was found in the centre. That implied a very remarkable form of segregation, and he asked if the segregation was influenced by allowing the ingots to remain after treatment in the soaking pit; how far did diffusion in the solid and semi-solid state either accentuate or tend to wipe out these differences of composition? His own impression was that so far as the metallic elements were concerned it would tend to wipe them out, but whether or not the segregation of sulphur or phosphorus would diminish was a point of very great interest, both practically and theoretically, because from it metallurgists might learn whether or not those elements were capable of diffusing through solid iron. Another point for investigation was that of fluid compression, particularly in the case of the Harmet process. He believed that in that process, at the top of the ingot, a highly segregated substance was squeezed out, and that was very interesting as throwing light on the processes which took place in segregation.

With regard to the determination of the liquidus and solidus of commercial steels, he said that a good deal of work on that subject had been done in his laboratory, and it had been found that the attempt to determine the solidus by the electrical resistance method had had to be abandoned, for the very reason that Professor Andrew had re-discovered, namely, that the effect of electrical conductivity was too small

* No. I. appeared May 11th.

to be definitely marked. The determination of the liquidus could be made with platinum thermo-couples quite well. Finally, he suggested that a pamphlet, summarising the leading facts in the report, would be of great value, so that outsiders, such as himself, could read it and understand it.

Professor C. H. Desch (a member of the Committee), said that the ingots used were representative of the regular practice of firms of good standing, and were provided by firms which were represented on the Committee. The production of the ingots, the sacrifice of them by cutting them up, and the grinding and surfacing and preparation of micro etchings and sulphur prints had been enormously costly, and that cost had been borne entirely by the steel industry. Naturally, the Committee had had a number of difficulties, but no difficulties had arisen through the withholding of information, and the spirit which had prompted the furnishing of such very full details in regard to productions of that kind—such details as had not, he believed, been published before—was to be very highly commended.

Mr. A. McCance, referring to the Committee's comparison of the degree of segregation between a 57-cwt. and a 15-cwt. ingot, and the statement that the results showed a distinctly higher degree of segregation for each of the elements in the former case, suggested that the figures given in Table III. of the report hardly bore out that contention, except in the case of sulphur. The range between the maximum and minimum sulphur content was certainly greater in the larger ingot, but the figures relating to carbon and phosphorus did not show a distinctly higher degree of segregation in the larger ingot. With regard to the design of moulds, the Committee stated that the correct taper was difficult to decide, as it depended on the rates of cooling at the freezing temperature in the various parts of the ingot, and that the taper should be such as to make possible efficient feeding of the body of the ingot. Those were expressions of opinion, and he would like to see a connected and detailed series of experiments carried out, so that people designing ingot moulds would know what was the best taper to use so as to diminish segregation.

Mr. J. G. Pearce (Director, British Cast Iron Research Association) said that the report hinted in a very delicate way at the lack of information on the properties of cast iron which determined the heat flow in ingot moulds. That was perfectly true, but he was able to say that, following a discussion between the Chairman of a Sub-committee of the British Cast Iron Research Association and himself, a meeting of the Sub-Committee had taken place recently at Sheffield, at which both makers and users of ingot moulds were represented. As a result of that meeting it was hoped to formulate, with the support of ingot mould makers throughout the country, a scheme for the systematic determination of those constants. In view of the fact that mould and ingot separated shortly after pouring, as mentioned in the first report, it seemed necessary in addition to determine temperature gradients by direct measurement, and that, of course, could only be done in the steel works. He supported the suggestion made by Dr. Rosenhain that a summary of the reports should be published. He feared, he said, that engineers who might not read the reports in detail, but might gather fleeting impressions from the illustrations, might feel that steel ingots were not what they had thought they were, and that we were discovering differences in composition which had not before been realised. A summary of the meaning of the reports might be given to one of the great engineering institutions, under the authority of the Committee, showing exactly, not how bad steel ingots were, but how much better they were than they used to be.

Professor J. H. Andrew, a member of the Committee, said that when that part of the report dealing with the researches at Glasgow—for which he was responsible—was written the work was in a very incomplete stage, but he believed that in a fortnight's time the complete set of freezing and melting points would be obtained. Commenting on Dr. Rosenhain's remarks as to methods of determining the liquidus, he said that, if he had had facilities such as were at the disposal of Dr. Rosenhain, he might have adopted the method suggested, but the cost of tungsten wire was about 1s. 6d. per foot, and of platinum about £3. He believed he had got very accurate determinations of the melting and freezing points. The solidus determinations appeared to be very sound.

Mr. T. M. Service (a member of the Committee) said that it was the general practice in certain surveys to ask for definite information on segregation in various parts of the ingots; it could be accepted that the ingots examined by the Committee did represent everyday practice. With regard to Dr. Rosenhain's question as to whether segregates were removed by long soaking, he said that unfortunately his experience was that the segregation still remained, and the generally similar types of ingots which had been split did not show that diffusion had taken place to any marked extent.

Mr. F. W. Harbord, Past-President, referring to the ingots cast from the electric furnace, asked whether the temperature was much higher than would have been the case had they been cast from the open-hearth furnace having the same charge. Presumably, he said, it would be rather on the high side.

Professor H. C. H. Carpenter, F.R.S., a member of the Committee, said that, like Dr. Rosenhain, he had been horrified to find how much detail had been lost in the reproduction of the illustrations. That was almost inevitable when the degree of reduction of size was so great, but, if it were possible, he would see that fresh reproductions were made of, at any rate, two or three of the Committee's very beautiful tracings, and would regard the cost as a first charge on the funds of the Institute. In emphasising the costly nature of the Committee's work, which, he said, had been rendered possible by the generosity of steel works in this country, he said that the cost must be thought of not merely in terms of thousands, but of tens of thousands of pounds, and in view of the fact that the steel industry had had to face such great difficulties during the past six years the credit due to the industry was all the greater.

Mr. E. A. Atkins, referring to future investigations, suggested that some experimental work might be carried out on the kind of additions which should be made to the ladle and their effect upon segregation—not only the amount of segregation, but the size of the inclusions. He was quite convinced that it was possible to make additions to the ladle which would affect the upward displacements of the inclusions, particularly if those inclusions could be made to coalesce. Another line of investigation which might be followed—though that was perhaps a little more fanciful—was to find out what would be the effect upon the steel of subjecting the moulds to intense vibration during solidification.

The President, referring to an investigation with which he had been concerned in 1894, in America, said that he had a particular iron which carried a lot of copper, from which spring steels were to be made, and he had to find out exactly whether the copper was going to segregate as did the metalloids. He had been very thankful to find that he had to confine his attention largely to carbon, phosphorus, and sulphide. Commenting on Dr. Rosenhain's suggestion that the Committee might investigate ingots which were rolled with liquid centres, he agreed that that would be a very interesting and important division of the Committee's work—if the funds would last out, for he realised how costly those investigations were. He suggested that an investigation of the pure form of ingot iron would be valuable.

Dr. Hatfield replied to the discussion. Dealing with Dr. Rosenhain's suggestion that a summary of the report, pointing out its salient facts, might be prepared, he said that although he understood that such a summary might be desirable, he did not see why the Committee should prepare it. The work had had to be done, and the report had had to be written, and surely it was not too much to ask those who were seriously interested in steel ingots to read the report. Regarding the future, he said that it was the intention of the Committee to put in hand constructive experiments, to test various avenues of possible improvement. At the same time he emphasised that it was not for the Committee only to undertake such work. The data in the report were now available to the industry of this and other countries; there was sufficient information in it to enable the technical world at large to draw its own deductions and make its own experiments, and he had reason to believe that the steel industry *was* drawing deductions and *was* utilising the information given for the improvement of technique.

Commenting on Dr. Rosenhain's remarks as to the representative nature of the ingots, he gave an assurance that many ingots of each size and class were cut and investigated, and even in the case of ingots weighing as much as 25 tons each, as many as half-a-dozen had been cut open, though the results relating to only one of them might be given in the report. It would have been impossible to have published the whole of the data made available. With regard to the question of diffusion, he said that in the first report of the Committee it was stated that sufficient evidence existed, based on the examination of blooms, to indicate clearly that the time/temperature effect resulting from soaking really did not lead to any substantial diffusion of the elements. However, since Dr. Rosenhain had raised the point, the Committee would see whether the general statements in the first report could be amplified. With regard to the Harmet process, he said that the Committee had previously expressed the wish to examine ingots produced under fluid compression, but apparently there were no such ingots left in the country. If any steel makers possessed ingots concerning the production of which sufficient information was available, the Committee would be glad to have the opportunity of putting that information on record.

With regard to the tapering of moulds, he said that Mr. McCance would find a little evidence if he studied the different designs of moulds given in the report.

Discussing Mr. Harbord's question as to temperatures, he said that it was felt that the science of determining high temperatures was not very advanced, and those physicists who were working in that field should be persuaded, and, if necessary, should be given financial assistance, to pay great attention to the subject. Replying to Mr. Atkins, he said that in tackling this subject the Committee was up against a wonderfully wide field of scientific requirements, and whilst as a Committee it was taking an interest in the physical chemistry of steel making, one could not expect it to make that its first plank, and he considered that other investigators should try to contribute more than had been contributed lately to the investigation of the physical chemistry of high-temperature steel making. Experiments had been made before on the effect of vibration during solidification, but without much promise of material advantage.

Concerning the President's remarks, he said that it had been the wish of the Committee to examine ingot iron, but, unfortunately, the firms represented on the Committee were not producers of that material, and the Committee would welcome an offer of such material in order that it might carry out an adequate examination.

The next paper was one by Mr. V. Harbord, entitled "A Comparison of the Most Important Methods Employed in the Cleaning of Blast-furnace Gas." The author presented the following summary and conclusions:—

CLEANING BLAST-FURNACE GAS.

(1) If a dust content in the gas of about 0·5 gramme is considered sufficient for the purposes required, this can be achieved by a washer of the tower and spray type without disintegrators or by electrostatic plants. If a lower dust content is required, a washer of the disintegrator type or a Halberg-Beth filtration plant is necessary.

(2) The Kling Weidlein plant cannot be regarded as a satisfactory cleaner, and to obtain reasonable results it should only be used as a primary cleaner in conjunction with some other form of cleaner. Its capital cost is too high for a first-stage gas cleaner, and unless used in conjunction with an electrostatic cleaner, one of its main claims—namely, retention of sensible heat—is lost.

(3) The cost of operating the electrostatic plants appears less than most other types of plants, but the average dust content in the cleaned gas is higher than with disintegrator washers. The sensible heat is retained, but the handling of the dry dust has some disadvantages. Improvements are still being made with this type of apparatus, which must be regarded as being still more or less in its infancy, and it will probably have a very big field in the future. The capital cost is high.

(4) The most efficient type of wet washers are of the combined tower and disintegrator type. The cost of running such plants is, however, higher than other types of cleaner, except the Halberg-Beth.

(5) The Halberg-Beth cleaner, if due attention is given to renewal of bags, gives a lower dust content in the final gas, and its cost of operation is no more than that of the more efficient wet cleaners. The two main objections to this plant are its high capital cost and the handling of the dry dust.

Mr. W. Simons said that, although the rough cleaning of gas might be useful, he was convinced that the only proper course to pursue was to clean the gas perfectly. He was not much concerned with the relative merits of one plant as compared with another, but it was an unfortunate fact that in this country there was a large number of blast-furnaces still in operation without any gas cleaning at all. Those who appealed for help for a depressed industry could not expect much help if they did not help themselves by securing the obvious advantages which the adoption of gas-cleaning apparatus offered. In the selection of a gas-cleaning plant, of course, one must be influenced by the size of the blast-furnace plant, but where there were five or six furnaces, and there was a continuous supply of gas, there was much to be said for the Halberg-Beth plant.

Mr. G. B. Butler said that up to the last year or so he personally had been rather against the Halberg-Beth process, but he was rapidly altering his views with regard to it. Probably one of the future developments, when the point at which blast-furnace gas was used in coke ovens was reached, would be the necessity to clean the whole of the gas, very probably by the Halberg-Beth process. He was obtaining fairly good results with the Kling Weidlein cleaner, and without it he would probably have been in a very much worse position than he was. One of the biggest mistakes made by nearly everybody in regard to gas cleaning was to look for one particular type of cleaner which would do everything, and he considered that the only way in which blast-furnace gas could be cleaned economically for use throughout the different departments of a works was to clean it in stages.

Mr. D. Sillars highly approved of the Halberg-Beth process, except in regard to its price. It was a most satisfactory arrangement for taking out the whole of the dust, but whether that was an economical arrangement was another matter. He emphasised the great necessity, when the wet cleaning process was used, of removing entrained water after the gas was cooled and cleaned. One type of plant which had not been mentioned by Mr. Harbord was one based upon a gas cleaner, which was very well known in gasworks in this country, for taking sulphuretted hydrogen out of gas by the washing method. In this country the plant was made only in small units, but there was a very large unit in America, about which he believed we should hear a great deal more. The principle was the use of one central shaft, upon which were mounted a number of discs, the discs being rotated by the shaft. A thin film of water was created by the centrifugal force of the machine acting on the water running over the discs. This new type of machine, he understood, was giving excellent results, and giving them in one apparatus—*i.e.*, the cooling and cleaning were carried out in one apparatus. A different construction was when the tower was divided into five or six different sections, each section being separately driven, instead of there being one long shaft to drive the whole tower from top to bottom. It was important to note that the power cost in that plant was very low, and that the bearings could be very well protected.

Mr. J. E. Holgate related his experience with regard to the purification of gas from a furnace making ferro-manganese. The dust was in a very finely divided

AERIAL VIEW OF AVONMOUTH DOCKS

state; indeed, it was more like fumes than ordinary dust. After consideration, it was concluded that the only method that could be applied under the particular conditions was the electrical method, and a plant was installed at a cost of over £30,000. It cleaned the gases very satisfactorily, but other difficulties had arisen. In the first place, the residents within half a mile, and even a mile, of the works had complained of the noise from the rapping of the pipes. There was another difficulty in regard to raising steam. Probably that could have been overcome on further investigation, but the plant had had to be shut down as the result of industrial depression.

Professor C. H. Desch said that one great difficulty with the electrostatic method was the extremely high potential that had to be used, leading to insulation difficulties, and so on, and he asked if the author had had experience of cleaning blast-furnace gas electrostatically at considerably lower voltage. He believed that in some cement works new electrostatic plants had been installed, working at a considerably lower voltage than that of the original Lodge-Cottrell plant. If that were so, it would mean a reduction in the cost of the electrostatic plant, and insulation difficulties would become less severe. He believed also that that type did not involve the rapping referred to by Mr. Holgate.

Mr. E. Bainbridge emphasised the necessity for considering carefully the type of dust to be dealt with before deciding upon the cleaning plant to be installed, and he referred to a case in which the dust to be dealt with had an extremely high water-soluble alkali content in the form of chloride. The semi-cleaned gas contained alkaline fumes, and he pointed out that the use of such semi-cleaned gas for stoves would very soon glaze the brickwork and result in considerable loss of efficiency. Dealing with the author's comparison of blast-furnace gas cleaners in Table I. of the paper, he asked on what temperature the figures of average dust content in clean gas were based, and whether they were all on one common basis. In that connection he said that in the case of one plant which was cleaning gas by a process in which the gas left the plant at a temperature between 200 deg. and 250 deg. Cent., the guarantee man had insisted upon calculating the dust content of the gas at 250 deg., which was misleading. It put the cool gas plants in an unfavourable position on paper, although in practice they would probably be very much better.

Mr. John Smeeton, who expressed agreement with Mr. Simons' contention that it was necessary to clean the gas thoroughly if one were to get the highest efficiency from it, pointed out that the cost of a plant depended on what it produced. In addition to the high efficiency with which thoroughly cleaned gas could be used, there was the advantage that the cost of cleaning the apparatus in which such gas was used could be saved. Most of the trouble with the heavy gas engines in this country had been due to imperfectly cleaned gas. The more thoroughly the gas was purified, whether by wet or dry cleaning plant—and it seemed fairly evident that dry cleaning was the more efficient—the greater was the return financially and in every other way.

Mr. Harbord, replying to the discussion, said that the question of whether to clean the whole of the gas thoroughly in the first place or to do it in stages and by-pass gas having a certain dust content to the stoves, was one in regard to which each individual user must make his mind up, having in view the costs under the particular conditions prevailing in each case. The effect of water vapour being carried mechanically along with the gas, as mentioned by Mr. Sillars, was very important. At one works he had visited it had been found that the dust content of the cleaned gas varied at different parts of the main, and if the gas were drawn from a point a little further along the main than that from which it was taken previously, so that the mechanical sprays had had time to settle and the gas had lost a portion of its moisture, the dust content was very much lower. It was believed that the moisture which was carried over mechanically was carrying the dust. The new American plant mentioned by Mr. Sillars was of very considerable interest, but his paper had been confined to plants in operation in this country. He was unable to give Professor Desch information about lower voltage cleaning, and had not heard of any plants being tried on those lines in this country, but if they were successful in cement works he had no doubt that Messrs. Lodge would thrash out the matter well with a view to applying it to blast-furnace work.

At this point the President had to leave the meeting, and Mr. F. W. Harbord (Past-President) occupied the chair for the remainder of the morning session.

(To be continued.)

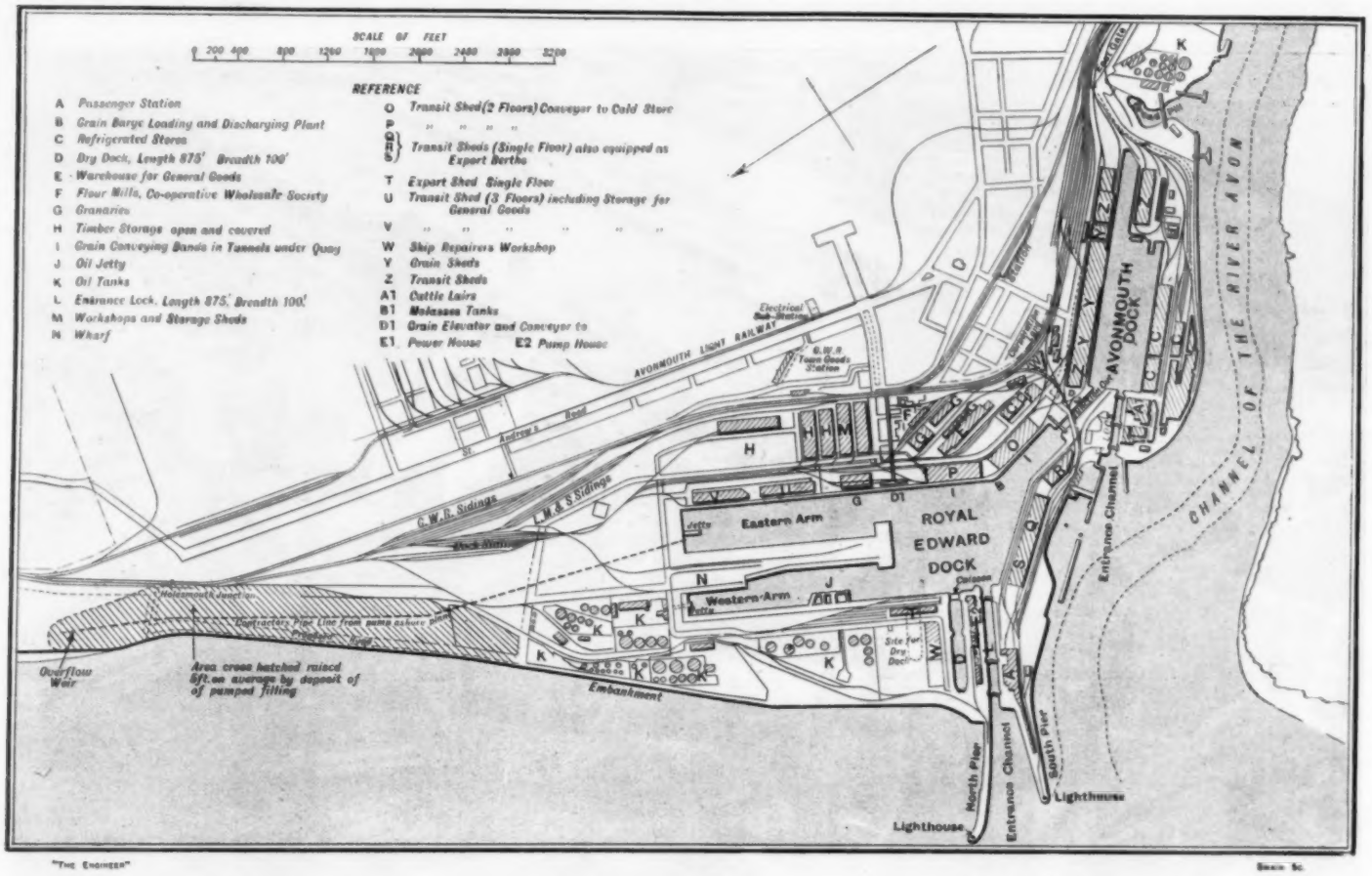
The Avonmouth Dock Extension.

No. I.

Nearly twenty years ago we recorded the opening by King Edward VII. of the dock at Avonmouth which bears his name, and gave an illustrated account of the works then just completed.* The Royal Edward Dock, opened on July 9th, 1908, was one of four considerable dock extensions at ports in the Bristol Channel which had been begun about the same time. The Queen Alexandra Dock at Cardiff was opened in 1907, and the King's Dock, Swansea, was brought into use in 1909; but the extensions at Newport, the last of the four to be undertaken, were not finally completed until 1914. The eastern arm of the Royal Edward Dock at Avonmouth, which is to be opened by H.R.H. the Prince of Wales on Wednesday, 23rd inst., is the first important addition to the dock water area in the port of Bristol effected since 1908. During the period of sixteen years intervening between the opening of the dock and the commencement of the eastern arm extension in 1924, several valuable additions had, however, been made to the equipment at Avonmouth. The former timber pond on the north-western side of the dock was deepened and equipped as an oil basin, a wharf and jetties being built in it for the accommodation of vessels discharging bulk oil cargoes, while most of the land area lying between the oil basin and the Severn embankment was leased to oil companies for storage purposes and is now thickly dotted with tanks. Five single-storey sheds covering about 330,000 square feet, built during the war period, were acquired by the Port Authority, and are now used mainly for timber and other storage. Cold storage of a total capacity of 500,000 cubic feet was added in 1920, and a second granary was completed in 1922. During the same period the warehouse and transit shed accommodation at the docks at Bristol, known as the City

* See The Engineer, July 3rd, 10th, 17th, 24th, 1908.

PLAN OF AVONMOUTH DOCKS SHOWING EXTENSIONS


SCALE OF FEET
0 200 400 800 1200 1600 2000 2400 2800 3200
REFERENCE
A Passenger Station
B Grain Barge Loading and Discharging Plant
C Refrigerated Stores
D Dry Dock, Length 875' Breadth 100'
E Warehouse for General Goods
F Flour Mills, Co-operative Wholesale Society
G Granaries
H Timber Storage open and covered
I Grain Conveying Bands in Tunnels under Quay
J Oil Jetty
K Oil Tanks
L Entrance Lock, Length 875' Breadth 100'
M Workshops and Storage Sheds
N Wharf
O Transit Shed (2 Floors) Conveyor to Cold Store
P " " " "
Q R S Transit Sheds (Single Floor) also equipped as Export Berths
T Export Shed Single Floor
U Transit Shed (3 Floors) including Storage for General Goods
V " " " " " "
W Ship Repairers Workshop
Y Grain Sheds
Z Transit Sheds
A1 Cattle Lairs
B1 Molasses Tanks
D1 Grain Elevator and Conveyor to
E1 Power House E2 Pump House
AVONMOUTH LIGHT RAILWAY
G.W.R. Town Goods Station
G.W.R. Sidings
L.M.& S.S. Sidings
Eastern Arm
ROYAL EDWARD DOCK
Western Arm
AVONMOUTH DOCK
Entrance Channel
CHANNEL OF THE RIVER AVON
Overflow Weir
Area cross hatched raised 5ft. on average by deposit of pumped filling
Embankment
North Pier
South Pier
Lighthouse
Lighthouse
"THE ENGINEER"

Docks, has been extended and large additions have been made to the tobacco stores.

History.

Before describing the latest development at Avonmouth it may be of interest to refer briefly to the history of the Bristol docks undertaking and its present position.

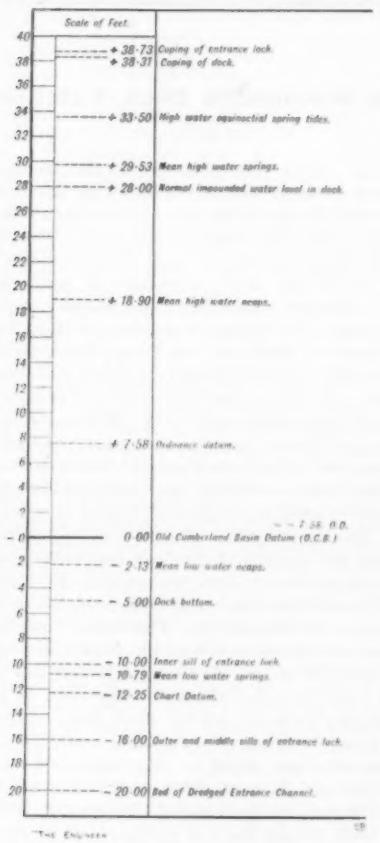

Scale of Feet.
+ 38·73 Coping of entrance lock.
+ 38·31 Coping of dock.
+ 33·50 High water equinoctial spring tides.
+ 29·53 Mean high water springs.
+ 28·00 Normal impounded water level in dock.
+ 18·90 Mean high water neaps.
+ 7·58 Ordnance datum.
0·00 Old Cumberland Basin Datum (O.C.B.)
– 2·13 Mean low water neaps.
– 5·00 Dock bottom.
– 10·00 Inner sill of entrance lock.
– 10·79 Mean low water springs.
– 12·25 Chart Datum.
– 16·00 Outer and middle sills of entrance lock.
– 20·00 Bed of Dredged Entrance Channel.
"THE ENGINEER"

FIG. 1—TABLE OF LEVELS

The first harbour work of any importance executed at Bristol was the construction of what is now known as the Floating Harbour, by the impounding of a reach of the tidal river Avon, about 2½ miles in length, and over 80 acres in extent, a new channel, which is still known as the New Cut, being excavated for the river on the south side of the city. This work, which was completed in 1809 by a private company, passed into the hands of the City Corporation in 1848. The Cumberland Basin entrance from the river, near the Clifton Suspension Bridge, about 6 miles above its mouth, was opened in 1873, and in 1884 the Corporation acquired the docks at Avonmouth and Portishead which had been built by private companies a few years previously. The City Docks have a water area of about 83 acres and contain nearly 15,000 lineal feet of quayage. Vessels of about 5000 tons deadweight capacity can navigate the Avon up to Bristol and enter these docks. The Portishead Dock of 12 acres on the west side of the Avon entrance, although of minor importance, receives some grain, timber and oil imports. The old Avonmouth Dock—see above—has a water area of 19 acres and 4800ft. of quayage. The depth of water on the sill of the entrance lock at high water of neap tides is 27ft. only, but as there is a communicating passage between the old dock and the newer Royal Edward Dock, the size of vessels which can use the former is not limited by the dimensions of its entrance lock. The lock at the Royal Edward Dock is 875ft. by 100ft., with 35ft. over the sill at high water neap tides—see diagram, Fig. 1. The water area of the dock is 62 acres and the length of quayage 8367ft. The total land area of the two Avonmouth docks is 852 acres. There are four large granaries at these docks, including the two erected in connection with the eastern arm extension which are described hereunder.

Municipal Expenditure on Docks.—The total capital expenditure of the city on the dock undertaking at various dates is shown by the following figures :—

1848	£424,781	..	Purchase money paid to old Dock Company.
1884	£789,525	..	Before acquisition of Avonmouth and Portishead Docks.
1894	£2,141,960	..	After acquisition of Avonmouth and Portishead Docks.
1904	£3,656,803	..	
1907	£5,429,235	..	Including part of the expenditure on the Royal Edward Dock.
1914	£6,351,660	..	Including the whole of the original expenditure on the Royal Edward Dock.
1917	£6,499,595	..	
1924	£7,374,993	..	
1927	£8,288,060	..	Including most of the expenditure on the eastern arm extension.

The net revenue of the Port Authority increased from £23,285 in 1884 to £124,739 in the year before the Great War and to £255,497 in 1927. The city of Bristol has always had to face a rate-in-aid of the dock undertaking from the borough fund, and this rate increased from £12,360 in 1884 to £122,500 in the year before the war. It is now, and has been for several years, reduced to £60,000 per annum. In 1927 £109,317 was contributed to the sinking fund

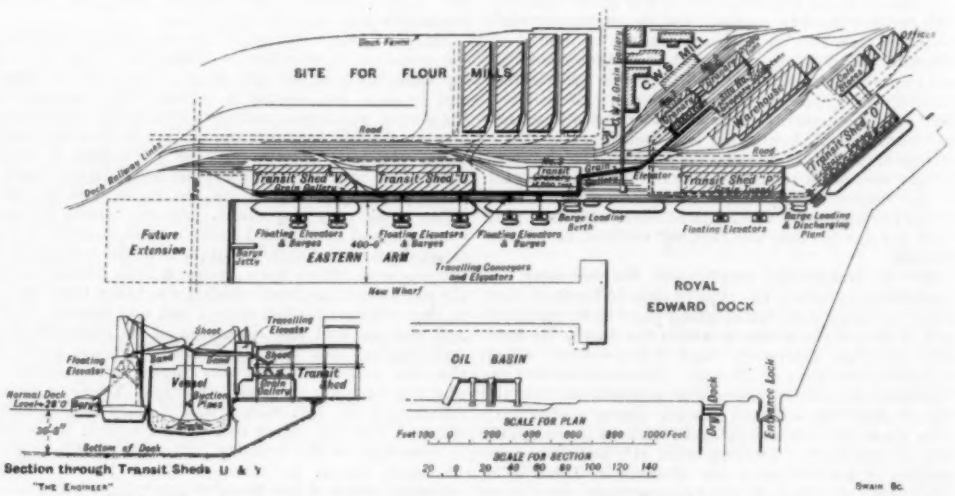


FIG. 2—EASTERN ARM EXTENSION OF THE ROYAL EDWARD DOCK

in redemption of capital and the amount standing to the credit of this fund in 1927 was £1,802,000. It may be mentioned here that Bristol is the only port of considerable magnitude in the United Kingdom the administration of which is in the hands of a municipality.

The Trade of the Port.—The net register tonnage of shipping entering the port has shown a steady increase, as will be seen from the following figures :—

Year.	No. of vessels.	Tons.
1884	8,364	1,246,236
1894	8,959	1,602,872
1907	10,053	2,135,122
1912	8,719	2,422,906
1914	8,685	2,491,829
1922	6,238	2,648,489
1924	7,234	3,335,909
1927	5,404	2,890,270

Since 1904 the tonnage entering the City Docks has decreased, the bulk of the increased trade being dealt with at Avonmouth. The largest ship which has entered the Royal Edward Dock is the ss. "Rotterdam" of the Holland-America Line, 650ft. long and 24,149 gross tons, and the ss. "Andes" of 15,620 gross tons has been dry-docked there. The bulk of the trade of the port is import traffic, which in 1927 amounted to nearly 4,000,000 tons, the exports in the same year being 486,436 tons. The import of grain, which amounted to 634,000 tons in 1907, increased to nearly 903,000 tons in 1922, but in 1927 fell to 789,314 tons; this, however, represented 10·5 per cent. of the United Kingdom import. Oil imports rose from 55,328 tons in 1907 to 418,532 tons in 1927, or 8 per cent. of the United Kingdom total. The banana trade represents about 50 per cent. of the total consumption of the kingdom, and reached over 6½ million bunches in 1926. The tobacco landed in the port of Bristol is about 26 per cent. of the total quantity entering the country, and the bonded warehouses at the City Docks accommodate 30,000 casks. The grain storage at Avonmouth totals about 100,000 tons, and there is accommodation for over 20,000 tons at the City Docks and nearly 30,000 tons at Portishead. The combined storage is equivalent to about 6 millions of bushels.

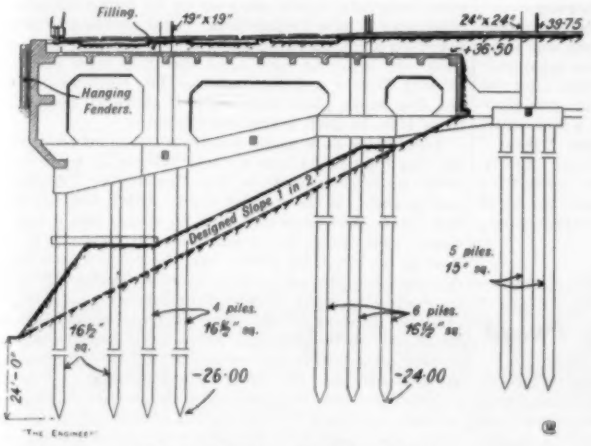


FIG. 3—SECTION OF QUAY WALL

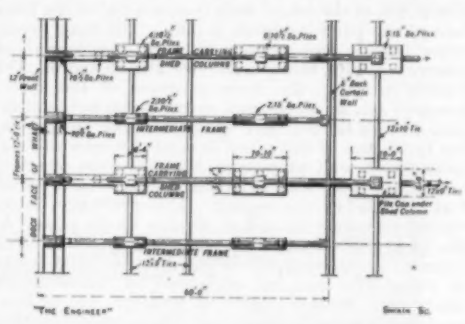


FIG. 6—PLAN OF PILES AND WHARF FRAMES

THE EASTERN ARM EXTENSION.

When the Royal Edward Dock was opened in 1908 two arms on the north side of the entrance lock and main basin had been planned as a part of the original scheme. These arms or branch docks would have added about 30 acres to the original water area of the docks, but their construction was left over until increase of trade should warrant the additional expenditure involved. The site of the western arm was partially covered by water, and its sides were formed of natural slopes, the shallow area thus formed being utilised as a timber pond. As we have already mentioned, this area was subsequently deepened and utilised as a petroleum basin. The reinforced concrete wharf, about 550ft. long, which was made on the eastern side of the western arm, is of somewhat similar construction to the wharves which have recently been completed in the eastern arm.

In 1918 the Port Authority obtained parliamentary powers to carry out a scheme of extension, including the works in the eastern arm; but, owing to the high cost of construction, the execution of the scheme was postponed. In 1923 the Unemployment Grants Committee offered some financial assistance to the City Council, and that induced the Port Authority to proceed with the work at an earlier date than would otherwise have been the case. The total expenditure on the scheme when completed will be about £1,250,000.

The Port Authority in January, 1924, accepted the tender of Sir Wm. Arrol and Co., Ltd., of Glasgow, for the construction of the main works, which were begun in March of that year, but some preliminary excavation had already been carried out by departmental labour.

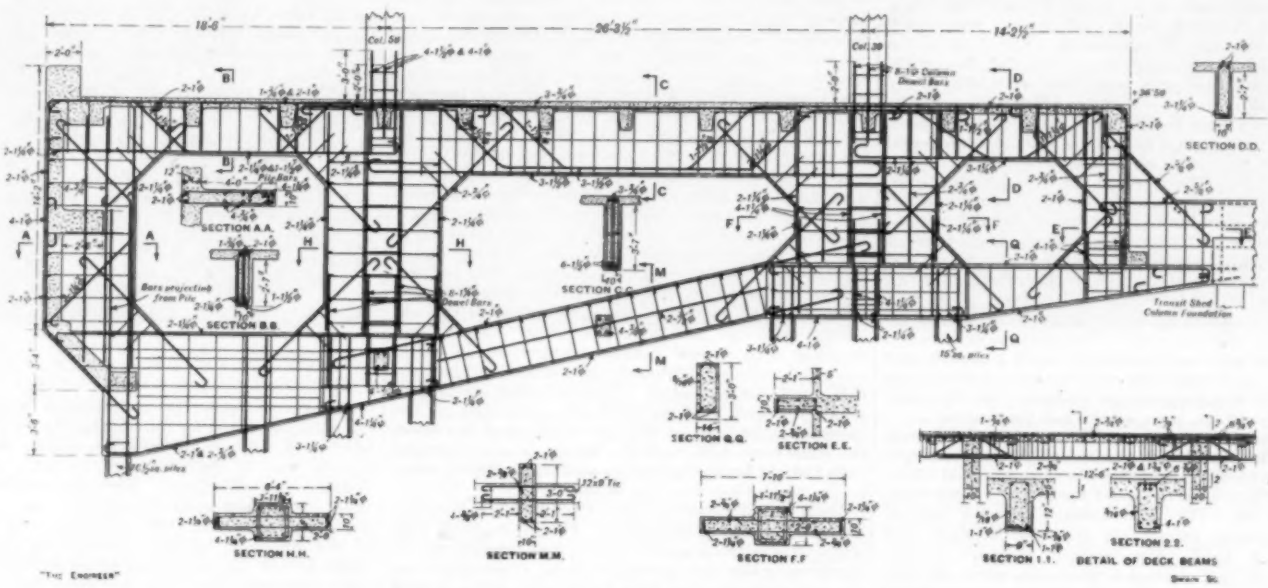


FIG. 4—REINFORCEMENT AND DETAILS OF TRANSVERSE FRAME

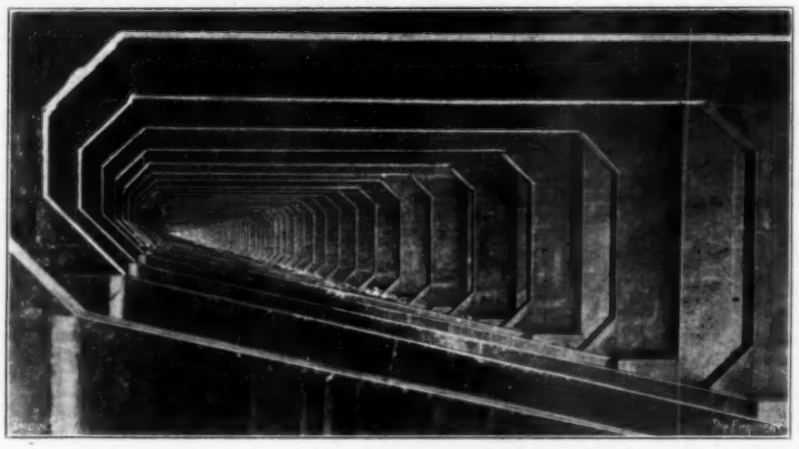


FIG. 5—VIEW UNDERNEATH REINFORCED CONCRETE ROOF

The principal works included in the eastern arm scheme—see Fig. 2—are the construction of reinforced concrete wharves on the east and west sides, each about 1700ft. long; the excavation of the arm 400ft. wide to a depth of 30ft. below impounded water level; two reinforced concrete treble-floor transit sheds; a transit silo-granary of 12,000 tons capacity; grain galleries and a silo-granary of 20,000 tons. All these works were carried out by Messrs. Arrol excepting a portion of the excavation, referred to above, and the dredging which was let as a separate contract. The grain-handling appliances and other mechanical equipment are referred to later. The entrance to the arm remains 300ft. in width as provided for when the Royal Edward Dock was constructed. Experience has shown that this width leaves insufficient room for large vessels to move to and from their berths when small craft are lying alongside large ships in the waterway. Consequently the width of the arm inside the entrance has been made 400ft. Views of the eastern arm showing the excavation, and the reinforced concrete wharves with the transit shed on the eastern side, are given in Figs. 7 and 8 on page 546.

The east side of the extension forms a prolongation of the eastern quay wall of the main basin, which is a gravity wall of very heavy section, the foundations being carried down, on the average throughout the dock, to 40ft. below O.C.B. Datum—see diagram, Fig. 1 The new wharf on this side is equipped with two transit sheds, a transit granary and the grain-conveyor gallery. The wharf on the western side of the arm is at present to be used only for the berthing of vessels, but when trade conditions warrant further equipment being provided it is intended to erect on it single-floor transit sheds and to provide railway sidings. The north end of the arm is formed by a pitched slope, down to 2ft. below normal impounded water level, and there is a small barge jetty 130ft. long projecting from it into the dock.

The new works present several features of interest

and novelty, not only in regard to the construction of the wharves but also in connection with the planning of the grain-handling plant.

Reinforced Concrete Wharves.

The whole of the wharf work is of reinforced concrete constructed in the dry behind an earth dam. The width of the wharf deck from coping to the back face of the piled structure is 59ft. The main transverse frames and groups of piles are spaced at intervals of 12ft. 6in. centres—see Figs. 3 and 6. The frames carrying the main supports of the sheds, granary, &c., are supported on twelve piles, the alternate frames having only six piles under them. On the front face of the wharf is a solid reinforced concrete fascia wall projecting 3ft. 6in. from the face line of the piles and extending down to a level of 14ft. 2in. below the coping. This projection is intended to reduce the risk of damage to the piles. At the back of the frames is a curtain wall of reinforced concrete supporting the filling behind to a height of 10ft. The material excavated in the arm is a sandy clay, known locally as bungum, which, after dredging, stands for some time with an almost vertical face. The design of the work contemplates an ultimate natural slope of 1 in 2 for the soil under the wharf. The heavy transverse frames were constructed on the pile heads, which were stripped down to expose the steel reinforcement to a height of 3ft. or more. The frames are, in effect, solid diaphragm walls with three lightening holes in each—see Figs. 4 and 5, while a view showing a section of the wharf and one of the reinforced concrete frames is given in Fig. 9, page 546. The frames provide the necessary transverse stiffness, and the deep fascia and curtain walls at front and back afford ample longitudinal bracing. The deck of the wharf consists of a reinforced-concrete slab, 5in. thick, which, behind the coping, is overlaid with 12in. of dry compacted filling covered with 5in. thick plain concrete slabs. Heavy cast iron bollards built into the reinforced concrete coping and fascia wall and anchored thereto are provided along the wharf front at intervals of 75ft. There are no fixed fenders, but from each bollard is hung by a wire rope a slightly rounded timber billet reaching to the water level. An unusual feature of the wharf work is the coating of the whole of the piles and all the reinforced concrete superstructure, including the upper surface of the deck, with two thick coats of road tar. This has been done with the object of ensuring, as far as possible, the impermeability of the concrete. The mixture of concrete used for the piles and reinforced work generally and the ample cover, which we refer to later, should result in a durable and impermeable material, but the coating of the surface is an additional precaution.

Piles and Pile Driving.—The reinforced concrete piles are 15in. and 16½in. square; they range in length from 54ft. to 62ft., and the heaviest weighed about 8 tons. They were designed for lifting at one point of suspension. The total number of piles driven, including those supporting the transit sheds and granaries, is 4582. The concrete mixture for the piles was 2½ : 1½ : 1, and a minimum cover of 1½in. of concrete over the steel reinforcement was provided for. The piles were cast on timber beds with side shutters of steel sheets. Beds were provided for 330 piles, and the area occupied by them was about 750ft. by 60ft. No pile was lifted from its bed until it was three weeks old. The concrete was poured by means of a short Insley tower on a carriage which also carried a Ransome mixer and the hoisting winch, the whole travelling on a 16ft. gauge track and being electrically driven.

The piles were driven before any excavation was done on the areas occupied by the wharves and other structures. Four 65ft. steel piling frames with drop hammers weighing 3¼ tons were employed for driving the piles—see Fig. 10, page 546. The electric piling winches were of the friction clutch type with rope made fast to the hammer. Each was driven by an 80 horse-power motor and they were made by J. H. Wilson and Co., Ltd., Birkenhead. Each frame was mounted on wheels on a steel undercarriage which was arranged for both longitudinal and cross travel. Two of the frames were kept continuously driving wharf piles while the other two drove the piles under the sheds and granaries. Each pair of piling frames was followed by a 10-ton Morgan steam derrick crane mounted on bogies, which pitched the piles and hauled the frame carriage along. All piles were driven down into the marly underlying the sandy clay. The specified set of ten blows per ½in. penetration with 3½-ton monkey and 3ft. 6in. drop was obtained without difficulty, and in some cases piles could not be driven quite to the intended level. When all four frames were working simultaneously they drove, on an average, about one hundred piles per week.

Wharf Construction Generally.—All the shuttering used in the construction of the reinforced concrete wharves, with the exception of the beam bottoms, was made of 12-gauge steel plates with angle stiffeners. The steel deck shutters were supported on 6in. by 3in. rolled steel joists which spanned the interval between the frames. The concrete mixer was placed behind the wharf and moved on as the work progressed. The concrete was handled by a 5-ton steam travelling crane with 65ft. jib travelling on 7ft. 6in. gauge track laid behind the wharf. In a normal week's work four complete bays of the wharf superstructure above the piles, consisting of an average of 220 cubic yards of concrete, were constructed. The concrete was poured in three stages: (*a*) the pile caps, ties and bottom member of front wall; (*b*) the main frames, consisting of columns, main beams and front and back walls; and (*c*) the secondary beams, deck and coping.

In the construction of the reinforced concrete wharves a minimum cover of 1½in. concrete was used throughout, including the piles. The coarse aggregate consisted of ¾in. graded hard limestone from quarries at Wickwar and Chipping Sodbury, Gloucestershire. The fine material was composed of the same stone crushed to ¼in. and under, with the fine "flour" extracted, and Holme sand from the Severn estuary in equal proportions. The normal mixture, except for the piles, was 3 : 2 : 1. A safe compressive stress of 700 lb. per square inch was allowed in the calculations.

(To be continued.)

New Road Bridge over the Tweed.

A NEW road bridge over the Tweed between Tweedmouth and Berwick, which has just been completed, was formally opened by the Prince of Wales on Wednesday last. It is consequently to be called the Royal Tweed Bridge. The fine old masonry bridge which has carried the Great North Road across the river at this point since it was built in the seventeenth century had become entirely inadequate for modern traffic requirements. It is too narrow for one thing, and, for another, its gradients are severe, being in places as steep as 1 in 11. Then, again, its approaches are tortuous and inconvenient. In fact, although it is a handsome structure and is possessed of much historical interest, it was decided by the three authorities concerned—the Ministry of Transport, the Northumberland County Council, and the Corporation of Berwick—that the time had arrived when a new bridge should be built. The questions then arose: Where should the new bridge be built? Should the old bridge be demolished and the new one built on its site? or should the old bridge be left and the new one built somewhere near it? It was eventually determined after various alternative schemes had been considered, to adopt the latter course. A predominating factor leading to this decision—apart from the natural desire to preserve an ancient and interesting historical relic—was the fact that the approaches to the old bridge were—as has been said—very narrow and winding, with several difficult corners, which would have had to be straightened out and widened had the first course been adopted. The new bridge starts from a point about 100 yards to the westward of the southern abutment of the old bridge and it crosses the river from S.W. to N.E., being not quite parallel with the old bridge, pointing, as it does, slightly more to the north than does the latter.

Both the old and the new structures are shown in the accompanying engraving. The photograph from which the latter was reproduced was taken from the northern or Berwick side of the river. As will be seen, the new structure is of pleasing design. It has a total length of 1410ft., which is made up as follows:—Starting from the south side there is an approach viaduct 204ft. long, which is followed by four arched spans 167ft., 248ft., 285ft., and 361ft. 6in. in length, respectively, and finally by a northern approach viaduct 144ft. 6in. in length. It has a total width between parapets of 46ft., there being a central carriageway 30ft. wide with two 8ft. footways on each side.

It was decided to build the bridge in reinforced concrete, and the design was entrusted to L. G. Mouchel and Partners, Ltd., of Westminster; Colonel C. H. Bressey, Chief Engineer to the Roads Department of the Ministry of Transport, and Mr. J. A. Bean, Surveyor to the Northumberland County Council, being appointed consulting engineers.

Because the northern bank of the river is considerably higher than the south bank, it was necessary to construct the bridge with a gradient of 1 in 51, and that fact necessarily had its influence on the design. There are two river piers to the north, then another pier on the south bank of the river, and north and south abutment piers. These may be conveniently designated as piers A, B, C, D, and E, going from south to north. Particulars of these piers, including the strata on which they are founded, are given in the following table:—

Particulars of Piers.

	Pier A, S. abutment.	Pier B.	Pier C.	Pier D.	Pier E, N. abutment.
	Ft. in.	Ft. in.	Ft. in.	Ft. in.	Ft. in.
Width	28 0	37 6	37 0	42 0	44 0
Length	55 0	58 0	82 0	83 0	62 0
Height	22 0	18 0	28 0	28 0	38 6
Founded on ..	Gravel	Sandy gravel	Gravel	Reinforced concrete piles	Shale & rock

Trial borings had pointed to the fact that the underlying strata consisted of rock and gravel, and for the most part those conditions were generally found to exist. In the case of pier D—which receives the thrust from the two larger spans—however, the excavation—which was carried out only a few feet to the west of the trial boring—disclosed, at foundation level, strata of peat and running sand which covered approximately one-half of the area of the site to be occupied by the pier. It was consequently decided to re-design that particular pier and to drive reinforced concrete piles over the whole area so as to make certain of obtaining a firm foundation. That work, of course, involved a considerable delay and additional expenditure. In order to save time the piles were made of Ciment Fondu and Ferrocrete. The foundations for the five main piers were carried down to depths of from 15ft. to 20ft. below river level.

The bridge as a whole has been designed to carry a moving load of 50 tons on four wheels in accordance with the requirements of the Ministry of Transport, but in addition the longest span—361ft. 6in. between the north abutment and pier D, which has a rise of nearly 45ft. 6in.—has been designed to carry a safe load of no less than 1000 tons, the other spans being designed for proportionately smaller loads. In order to keep the sizes of the foundations as small as possible the arched ribs were designed as continuous from pier A to pier E. Each arch comprises four reinforced concrete ribs arranged at 15ft. centres, one at each side and two under the roadway. They are monolithic with the piers and abutments, which are of mass concrete with a certain amount of reinforcement, and faced with a strong concrete mixture. The upstream and downstream ends of the river piers—C and D—are shaped to form cutwaters. The river piers were built inside cofferdams, which were formed by means of 16in. by 5in. B.S. piling driven by a McKiernan-Terry steam hammer.

The high water level of spring tides comes at 7·83ft. above Ordnance Datum, the low water of spring tides being 7·17ft. below Ordnance Datum. The full range of tide is therefore just 15ft. The level of the springing of the arches on the river piers is 9·5 above O.D., or 0·67ft. above H.W.O.S.T. In the following table are set out the principal dimensions and spans of the main arch ribs:—

Particulars of Arch Ribs.

	Span 167′ 0″	Rise 29·8′	Span 248′ 0″	Rise 35·39′
	Crown.	Springing.	Crown.	Springing.
Ext'l ribs ..	2′ 1″ × 4′ 0″	2′ 1″ × 6′ 0″	2′ 10″ × 5′ 6″	2′ 10″ × 8′ 9″
Inter'l ribs	3′ 6″ × 4′ 0″	3′ 6″ × 6′ 0″	4′ 0″ × 5′ 6″	4′ 0″ × 8′ 9″
	Span 285′ 0″	Rise 40·107′	Span 361′ 6″	Rise 45·445
	Crown.	Springing.	Crown.	Springing.
Exter'l ribs	2′ 10″ × 6′ 0″	2′ 10″ × 9′ 6″	3′ 2″ × 7′ 0″	3′ 2″ × 10′ 6″
Intern'l ribs	4′ 0″ × 6′ 0″	4′ 0″ × 9′ 6″	5′ 0″ × 7′ 0″	5′ 0″ × 10′ 6″

The thrust from the arch ribs is transmitted to the mass concrete pier foundations by means of heavy reinforced concrete distribution beams, and the reinforcing bars of the ribs were carried a considerable distance into the piers. The ribs of the smallest—167ft.—span are solid throughout, but in the three remaining spans, in order to reduce the deadweight of the structure on the foundations, the ribs were made hollow for about one-third of their span from each springing, but they are solid over the crown. From the arch ribs the main longitudinal beams are carried by columns and spandrel walls. At the crown the arch ribs carry the cross beams and decking, the whole being monolithic. The dimensions of the columns are varied to suit the loads which they will have to carry, and, over the piers, the columns are tied by means of raking struts so as to form a triangular system of columns and struts which transmit the wind pressure direct to the main piers.

The outside longitudinal beams are 48in. deep by 10in. wide, while the inside beams measure 36in. by 10in. Spaced at about 4ft. 6in. centres between them are 20in. by 7in. secondary beams, above which comes the decking 8in. thick, formed with the required camber of the roadway. Above the decking comes the surfacing material, which, for the wearing surface of the carriageway, is Carpave 2in. thick. Ducts for the public services are formed under the footways and are covered with concrete flagstones. Provision has, of course, been made for draining the roadway, footpaths and ducts. Over the centre of each pier a butt expansion joint has been formed in the beams and decking, and it is continued by means of a rebated joint up through the parapets.

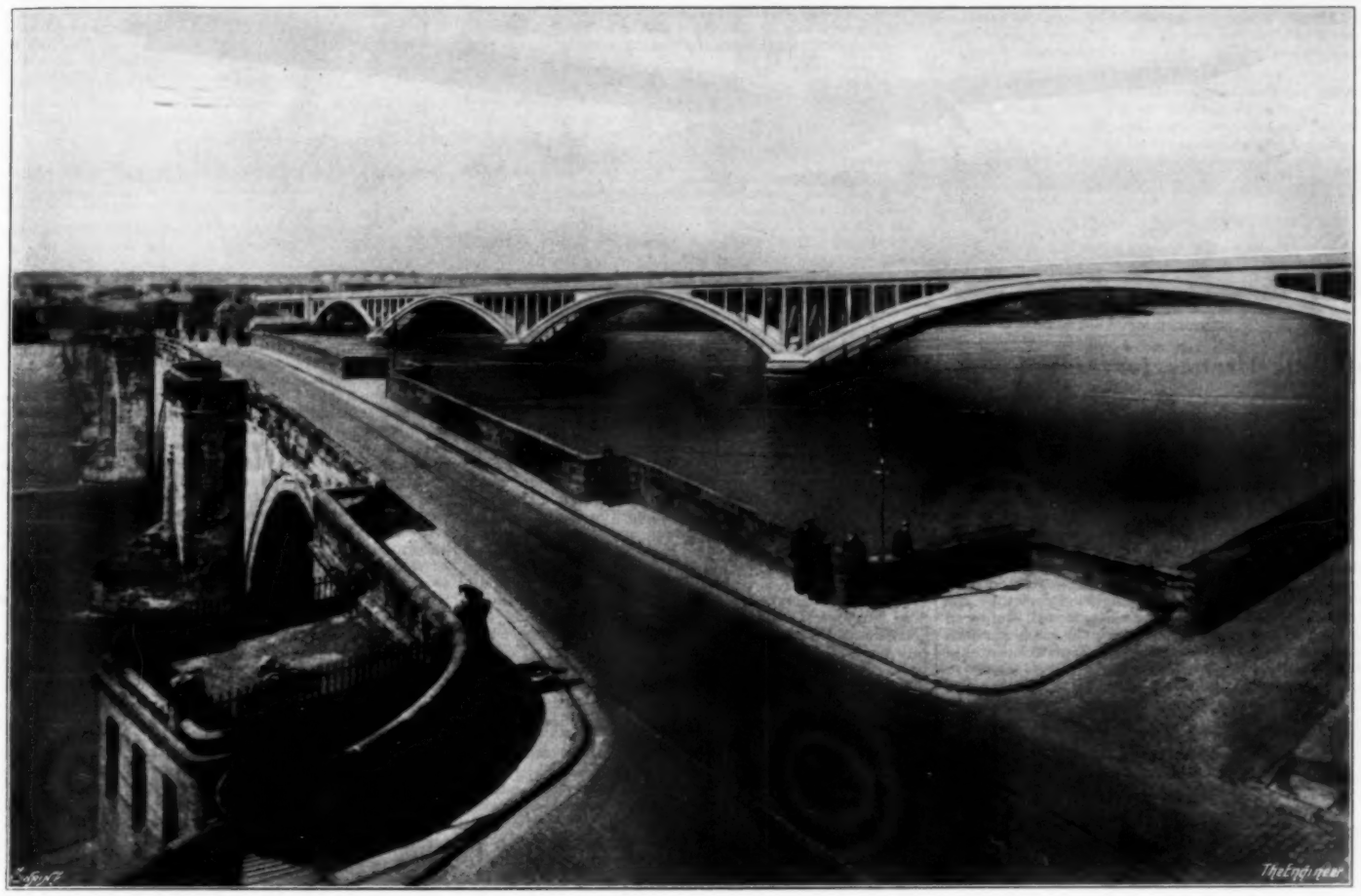
The approach viaducts consist of longitudinal beams, cross beams and decking of a similar character to those in the arch spans. They are supported on reinforced concrete columns, which transmit the load to the solid ground through the usual type of foundation slabs. The construction of these viaducts did not involve features of particular interest or difficulty.

With the exception of the materials used for the construction of the piles under pier D, Portland cement was used throughout the structure. The available sands were tested and a mixture of two parts coarse to one fine sand was adopted and used throughout. The aggregates employed were as follows:—

50 per cent. Whinstone, ¾in. to ¼in.
25 per cent. Scremerston gravel, ¾in. to ¼in.
25 per cent. Scremerston gravel, ¼in. to ¼in.

These proportions were arrived at after a number of tests had been made, both for grading and strength before the reinforced concrete work was begun. Crush-

OLD AND NEW ROAD BRIDGES OVER THE TWEED AT BERWICK



ing tests were carried out on cubes of 50 per cent. each of whinstone and gravel.

The parapets are formed of sandstone masonry, the stone for which was obtained from the Bird's Nest Quarry at Walker, Newcastle-upon-Tyne. Its colouring tones very well with that of the reinforced concrete.

The building of the bridge necessitated the construction of approach roads on both sides of the river, and the formation of these roads involved the demolition of a certain amount of buildings which, however, were of a poor and very inferior kind. The width of the approaches is 60ft. between fences, the actual carriageway being 30ft. wide—the same width as that on the bridge.

The contractors for the work were Holloway Brothers (London), Ltd., of Bridge Wharf, Grosvenor-road, S.W. 1, and the resident engineer was Mr. P. I. Payne, Assoc. M. Inst. C.E.

The Institution of Civil Engineers.

ROYAL CHARTER CENTENARY.

The Institution of Civil Engineers has prepared the following additional particulars of the programme for the Engineering Conference which is to be held from June 3rd to 7th next, in celebration of the centenary of its incorporation by Royal Charter. A general outline of the programme was given in our issue of March 30th last. It will be remembered that the President, the Council, delegates and members will attend a service in Westminster Abbey on Sunday, June 3rd. On Monday morning the President will deliver an address, and the delegates will be received by the president and council, in the Great Hall of the Institution. In the afternoon the thirty-fourth James Forrest Lecture will be delivered by Sir James Alfred Ewing, K.C.B., F.R.S., M. Inst. C.E. On the Tuesday evening there will be a Conversazione at the Institution, and on the Thursday a Banquet will be held at the Connaught Rooms.

The following subjects have been chosen for discussion:

Tuesday, June 5th.—In the Great Hall of the Institution, 10.30 to 11.45 a.m., "Recent Developments in Concrete and Cement for Engineering Structures," introduced by Mr. F. E. Wentworth-Shields; 11.45 to 1 p.m., "Developments in the use of Materials in Railway Engineering," introduced by Mr. C. J. Brown, and "Railway Design and Maintenance as affected by the Application of Electricity," introduced by Messrs. A. R. Cooper and George Ellson.

In the Theatre of the Institution, 10.30 to 11.45 a.m., "Steel for Shipbuilding," introduced by Sir William J. Berry, K.C.B.; 11.45 a.m. to 1 p.m., "The Generation and Utilisation of High-pressure Superheated Steam for Marine Propulsion," introduced by the Right Hon. Lord Weir, P.C., and Mr. Harold E. Yarrow, and "Progress in the Adoption of the Internal Combustion Engine for Marine Purposes," introduced by Professor C. J. Hawkes.

In the Library of the Institution, 10.30 to 11.45 a.m., "Utilisation of Solid and Liquid Fuels," introduced by Dr. C. H. Lander, and "Coke Oven, Town and Producer Gas," introduced by Mr. Robert Ray; 11.45 a.m. to 1 p.m., "Waterless Gasholders," introduced by Mr. Frank Prentice.

At the Institution of Mechanical Engineers, 10.30 to 11.45 a.m., "The Properties of Materials for Use at High Temperatures, with special reference to Boilers for Superheated Steam," introduced by Mr. R. G. C. Batson; 11.45 a.m. to 1 p.m., "The Present Trend in Boiler Practice," introduced by Mr. W. H. Patchell.

At the Surveyors' Institution, 10.30 to 11.45 a.m., "Electric Transmission of Power as applied to Large Areas," introduced by Mr. Archibald Page; 11.45 a.m. to 1 p.m., "Domestic Lighting and Heating and its Influence on Load Factor of Supply," introduced by Mr. A. F. Berry.

Thursday, June 7th.—In the Great Hall of the Institution, 10 to 11.30 a.m., "The Dimensions of Harbour and Dock Approaches," introduced by Sir Cyril R. S. Kirkpatrick, and "Harbour Breakwaters," introduced by Mr. H. H. G. Mitchell; 11.30 a.m. to 1 p.m., "Modern Road and Bridge Construction," introduced by Mr. F. C. Cook, D.S.O., M.C., and "The Problem of Road Traffic from the Engineering Point of View," introduced by Mr. H. R. Hepworth.

In the Theatre of the Institution, 10 to 11.30 a.m., "Latest Types of Steam and Internal Combustion Locomotives," introduced by Sir Henry Fowler, K.B.E., and Mr. H. N. Gresley; 11.30 a.m. to 1 p.m., "Light High-speed Internal Combustion Engines," introduced by Mr. H. R. Ricardo, and "Heavy Internal Combustion Engines," introduced by Mr. Geoffrey Porter.

In the Library of the Institution, 10 to 11.30 a.m., "The General Trend of Modern Development in Steam Turbine Practice," introduced by Mr. H. L. Guy; 11.30 a.m. to 1 p.m., "Prospective Development in the Generation of Electricity and Its Influence on the Design of Station Plant," introduced by Dr. S. L. Pearce.

At the Institution of Mechanical Engineers, 10 to 11.30 a.m., "Tidal Power and Turbines suitable for its Utilisation," introduced by Professor A. H. Gibson, D.Sc., and "Progress in Hydro-electric Installations, including Intakes, Leats, Tunnels, Dams, Head-races, Pipe Lines and Tail-races," introduced by Mr. J. McLellan, D.S.O., M.C.; 11.30 a.m. to 12.15 p.m., "Problems Involved in Mining at Great Depths," introduced by Mr. James Whitehouse; 12.15 to 1 p.m., "The Metallurgy of Complex Lead-Zinc-Copper Ores," introduced by Mr. Samuel Field.

At the Surveyors' Institution, 10 to 11.30 a.m., "The Filtration and Treatment of Water for Domestic Purposes," introduced by Sir Alexander Houston, K.B.E., C.V.O., and Mr. H. E. Stilgoe, and "Floods, with special reference to Waste Weir Capacity," introduced by Mr. W. J. E. Binnie and Dr. H. Lapworth; 11.30 a.m. to 1 p.m., "The Advantages of Different Types of Sewage Tanks," introduced by Mr. W. Clifford, and "Sewerage, with special relation to Run-off," introduced by Mr. J. B. L. Meek.

The following visits to works have been arranged:—

Tuesday Afternoon, June 5th.—A.—The Fuel Research Station, East Greenwich; B.—The General Electric Company's Lamp Works, Hammersmith; C.—The Post Office Tube Railway at Paddington, and the Tandem and Holborn Telephone Exchanges; D.—The Pumping Stations of the Metropolitan Water Board at Kempton Park and Walton; E.—The Overhaul Works of the London Underground Railways at Acton; and F.—The Deptford West Power Station, under construction for the London Power Company.

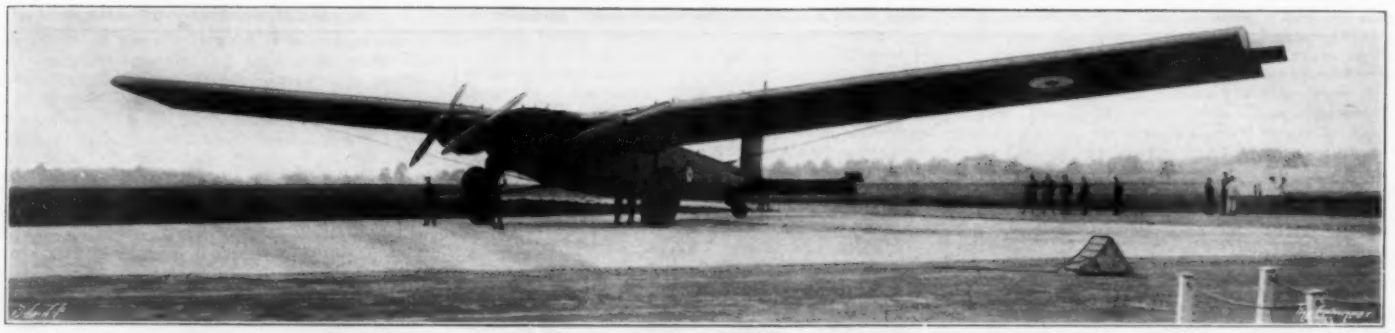
Wednesday, June 6th.—G.—The Works of W. H. Allen and Co., Bedford, and the Engineering Laboratories, Cambridge University; H.—The Works of Morris Motors (1926), Ltd., at Cowley, Oxford, and Oxford University; J.—The Port of London; K.—The Locomotive Works of the London, Midland and Scottish Railway at Crewe; and L.—The East Hecla Works of Hadfield, Ltd., at Sheffield.

Thursday Afternoon, June 7th.—M.—The National Physical Laboratory, Bushy Park, Teddington; N.—The Works of D. Napier and Son, Ltd., Acton; O.—The Fraser and Chalmers Engineering Works, at Erith; P.—The reconstruction work of Piccadilly Circus Station, London Underground Railways; Q.—The works of the Wandsworth, Wimbledon and Epsom Gas Company, at Wandsworth; R.—The Research Laboratories of the General Electric Company, at Wembley; and S.—Recent road reconstruction work on the East Side of London.

VOSGES RAILWAYS.

Less favoured than the Pyrenees and the Alps, where important railway undertakings are being completed, the Vosges are still waiting for the putting in hand of the three schemes which are to connect up the French railway system with Alsace-Lorraine by shorter routes through the mountain range. Immediately after the Armistice it was proposed to construct without delay three lines which would involve the tunnelling of the Vosges, but as the restored provinces are already served by the railways from Nancy to Strasburg and from Belfort to Mulhouse, it was deemed advisable, in view of the unsatisfactory financial situation, to let the schemes remain in abeyance for the time being, and work was continued on the line from Saint-Dié to Saales, which was regarded as being of a more urgent and less costly character. The length of the line is 15¼ miles. From Saint-Dié it follows the Meurthe, which it crosses at Sainte-Marguerite, and then continuing up the valley of La Fave rises by easy gradients until it traverses the Vosges by a helicoidal tunnel 1600 m. long. A large number of bridges, viaducts and short tunnels have had to be constructed. The line will be completely terminated during the present year. While railway communication with the restored provinces is being improved, there appears little hope of anything being done to meet the needs of Alsace in the way of electrifying the system. It was expected that some of the energy to be provided by the power stations on the proposed lateral canal would be available for the purpose, but, for reasons of national defence, it is understood that there will be no electrification of railways in the frontier province.

BEARDMORE "INFLEXIBLE" ALL-METAL MONOPLANE



Hydraulic Brakes for Aeroplanes.

SEVERAL attempts have been made in the past to devise and fit a satisfactory system of brakes on aeroplanes. In some cases, as, for example, in the Hill "Pterodactyl," or tailless aeroplane, it has been sought to obtain an aerodynamical braking action by a manipulation of the flying organs. In others an attempt has been made to apply a mechanical braking force by restricting the freedom of the landing wheels on their axles after the manner in which the wheels of a motor car are braked. At present the success of these methods may be judged from the fact that the vast majority of aeroplanes are not fitted with brakes. They are pulled up after alighting partly by the increased head resistance presented when the tail is allowed to sink down to bring the machine into the alighting attitude and partly by the ploughing effect of the tail skid over the ground.

With a machine of relatively small size the braking force generated in these two ways is generally sufficient to ensure the machine pulling up within a reasonable distance after the wheels touch the ground, particularly if the landing is, as it should be, made against the wind. As the size of the machine is increased, however, the increased momentum necessarily involves a greater application of braking force to pull the machine up in a given distance, and hence in very large machines an efficient braking system becomes practically essential. An aeroplane in the air is as graceful as a swallow, but once she touches ground she becomes a very ugly duckling indeed, and anything that will reduce the length of run required for pulling up and the subsequent taxying over the aerodrome to reach the alighting point, is to be commended from several points of view.

The huge all-metal monoplane, known as the "Inflexible," which Wm. Beardmore and Co., Ltd., have built for the Air Ministry for experimental purposes, and which successfully passed its official trials at Martlesham Heath at the beginning of March, is fitted with a braking system of great interest. This machine, of which we reproduce a general view herewith, weighs when fully laden about 16 tons. It has a wing spread of approximately 155ft. and an overall length of about 76ft. It is driven by three Rolls-Royce "Condor" engines, each rated at 650 horse-power. The landing wheels are 7ft. 6in. in diameter.

The braking system is of the Lockheed hydraulic type, and is similar to that fitted to many designs of motor car. We are informed that preliminary tests have shown that the use of the brakes reduces the landing distance required by a large aeroplane, such as the "Inflexible," by 30 per cent., and that further tests are expected, when the full pressure is applied, to show a reduction of 45 to 50 per cent.

The Lockheed brake system, as our readers are doubtlessly already aware, replaces the ordinary mechanical braking system of a motor car with its numerous rods and links by a simple arrangement of copper piping, through which hydraulic pressure is transmitted to cylinders, the pistons of which are connected by levers to the ends of the straps surrounding the brake drums. The hydraulic pressure required to tighten the straps on the drums is created by the pressure of the driver's foot on a pedal which forces in the piston of a master cylinder. When the pressure of the foot is released the piston of the master cylinder returns to the inoperative position under the action of a spring. Simultaneously the brake straps are slackened by pull-off springs associated with the straps. In actual motor car practice shoes lying within a drum are generally used instead of straps lying outside a drum. The hydraulic fluid employed is a mixture of neutralised castor oil and denatured alcohol treated with chemical reagents, which counteract the action of the fluid on the metal and rubber parts of the system. Means are provided for compensating the effect of temperature changes. Should the temperature rise some of the fluid is automatically by-passed into a supply tank, and should it fall some fluid is drawn from the tank. As a result of the volume of fluid in the system, excluding the supply tank, remains constant at all temperatures. Movement of the chassis relatively to the wheels is accommodated by the insertion of flexible lengths of hose in the run of copper piping. This hose is formed of fabric and rubber. It is subjected to a hydraulic pressure of 1200 lb. and while it is so subjected a closely wound coil spring, $\frac{3}{4}$in. in outside diameter, is inserted into its bore. When the pressure is released, the hose contracts on the spring. By this process the internal volume of the hose is made to remain constant under all pressures from zero up to 1200 lb., a pressure beyond anything ordinarily reached in the operation of the brakes.

It will be readily understood that the braking of an aeroplane presents features not found in the braking of a motor car. When the machine is in the air the application of the brakes has no effect on its motion. When it is running on the ground after alighting or just before taking off the application of the brakes in too hard a degree may cause the machine to tip over on to its nose with serious, possibly fatal consequences to the pilot and his companions. In the Lockheed system, as applied to the "Inflexible," this grave possibility is avoided by arranging the details in such a way that while the force applied to the brake drums is under the control of the pilot, its application is automatically effected by the movement of the tail skid when it touches the ground. If after alighting the machine tends to throw its nose down as a result of the brakes being applied too harshly, the tail skid will lift off the ground and, as a consequence, the brakes will be released.

The accompanying diagram illustrates the principle of the Lockheed aeroplane braking system. There are three master cylinders, A, B, C, instead of one as in the motor car equipment. The cylinder A works in conjunction with the tail skid. The connections between the skid and the piston include a cam arrangement which limits the movement of the piston to 1in. whatever the movement of the skid may be. The cylinder B is fitted in the pilot's cockpit. Its piston is operated through a hand lever and toggles, which give a leverage of 40 to 1 and a movement of 1¼in. to the piston. The pilot's lever is fitted with a ratchet so that it may be fixed in any position on the quadrant. The pressure created by the movement of the pilot's lever is shown on a gauge. The cylinder C is designed to limit the pressure which can be applied to a maximum which is short of that which will cause the tires to skid on the ground. To this end the piston is opposed by a spring behind it, the strength of which is adjusted to suit the desired maximum pressure.

When the machine is in flight and about to land the pilot applies pressure to the system by moving his lever to the required extent. This pressure will take up the slack of the straps round the brake drums, but will not actually apply the braking force. That force will become effective only when the tail skid touching the ground forces in the piston of cylinder A. The extent to which the pilot takes up the slack of the straps will determine the magnitude of the braking force applied by the tail skid cylinder.

As an alternative method of working, the pilot may land with his brake lever in the inoperative position. The tail skid cylinder, when the skid touches the ground, takes up the slack, and the actual braking force is applied by the pilot from his hand lever.

When the machine is taking off the pilot's lever is set into the inoperative position. So long as the tail skid is on the ground the piston of cylinder A will be pressed inwards, to an extent which cannot, however, exceed 1in. This displacement with the piston of cylinder B in the full out position is sufficient only to take up the slack of the straps. The brakes therefore remain unapplied and the wheels are free to revolve.

The considerable movement of the fuselage of an aeroplane relatively to the landing wheels when the machine is alighting or taking off has been one of the chief difficulties in the design of a satisfactory system of mechanical brakes for aeroplanes. In the Lockheed system this difficulty is overcome in the same manner as in the case of a motor car, namely, by fitting flexible hose couplings at appropriate points in the hydraulic piping.

The European representative for the Lockheed system is the Automotive Products Company, 3, Berners-street, London, W. 1.

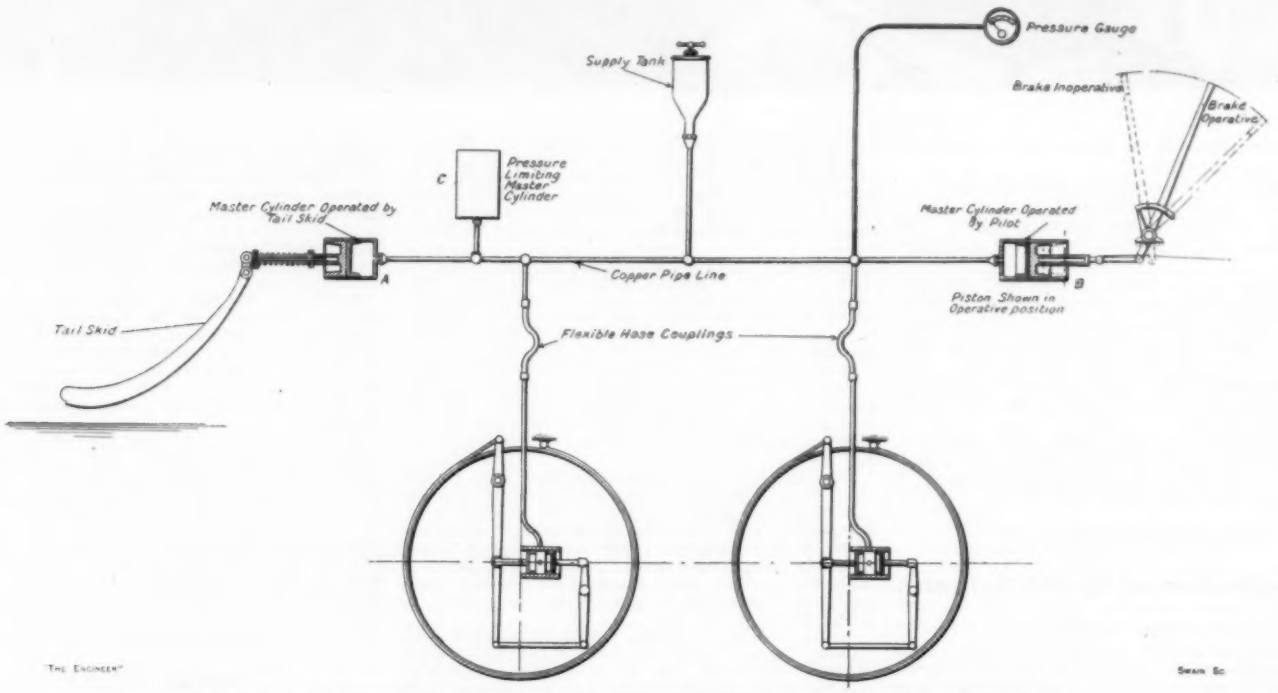


DIAGRAM OF LOCKHEED HYDRAULIC BRAKE SYSTEM FITTED TO "INFLEXIBLE" MONOPLANE

Railway Matters.

THE new steamer, the "Worthing," for the Newhaven-Dieppe service was launched by William Denny and Brothers, Ltd., of Dumbarton, on May 3rd. She will be the first oil-burning vessel in that service, will have a speed of 24 knots and have accommodation for 1500 passengers. The service is jointly owned by the Southern Railway Company and the French State Railways.

WE are informed that the Institution of Locomotive Engineers (London) proposes to visit Cologne, Cassel and Berlin to inspect some of the principal works relating to railways in those cities, also places of interest in the vicinity. It is intended to leave London on Saturday, June 9th, at 8.30 p.m., from Liverpool-street Station, and to return to London on Sunday, June 17th.

SPEAKING at the Railway Benevolent Institution dinner on May 2nd Colonel Wilfrid Ashley said, as to the proposed inquiry into transport, that there were many aspects of the question—political and industrial, the relations between masters and men, and between private enterprise and State and municipal enterprise—indeed the whole of our internal life might come under the review of the Commission. He intended to draw the terms of reference in such a wide way that no reasonable aspect of the question should be eliminated from discussion.

IN our last two Annual Articles on Railways mention has been made of the Longbridge and Barnt Green widening, on the Birmingham and Gloucester section of the London, Midland and Scottish Railway, which includes the opening out of the Cofton Tunnel, 440 yards long and 80ft. deep. The latter work has made such progress that it was intended to destroy one of the last remaining sections on Sunday last. Men were engaged on Friday in laying sleepers on the track to protect the rails when the roof fell being damaged, when, without warning, the section collapsed. Several workmen were caught and four of them killed.

CANADIAN railways made new high records in 1927 in gross revenues which were the largest ever earned, in tons of goods carried and in revenue ton-miles. The official Government statistics of steam railways with annual operating revenues of 500,000 dollars and over, issued by the Dominion Bureau of Statistics, give the pay roll as larger than in 1926 by 14,062,444 dollars and exceeded only by the 1920 pay roll. Although gross operating revenues were greater than in 1926 by 5,414,075 dollars, or 1·1 per cent., the operating expenses increased by 18,144,900 dollars, or 4·7 per cent., which reduced the net operating revenues by 12,720,825 dollars. Total railway operating revenues came close to half a billion dollars at 493,574,321 dollars, compared with 488,160,246 dollars in 1926. Operating expenses increased, however, from 384,615,064 dollars in 1926 to 402,759,964 dollars in 1927. Operating income, after making allowance for railway tax accruals, hire of equipment, &c., amounted to 80,535,605 dollars in 1927, compared with 93,179,391 dollars in 1926. The mileage of road operated shows a gain of 350 miles at 39,427, compared with 39,077 miles in 1926. The new record in tonnage carried was 121,616,686 tons, compared with 119,494,165 tons in 1926. In revenue ton-miles, which also created a new high record, the total was 34,800,203,879, compared with 34,049,369,809 in 1926.

THE Ministry of Transport Officer's report on a derailment on a Scottish railway, caused by a broken carriage axle, has received some prominence in the daily Press. It is fitting therefore that we should point out that such failures are extremely rare. The failures of axles have been the subject of special reports by the railway companies, which are provided with forms used only for that purpose. During last year only two such cases were reported, and during the five years ended December 31st, 1927, there was, on all the British railways, a total of twenty-six failures of carriage wheels or an average of, say, five a year. There are 72,000 coaching vehicles, the large majority of which have four axles, but some have six and some three, whilst many brake vans, horse boxes, &c., have only two. Taking the average at three means that there has been one failure a year to every 40,000 axles. Another test as to the freedom from that class of accident is that since the year 1917 there has been no occasion to hold a Government inquiry into an accident caused by the failure of a carriage axle, and not since April 25th, 1902, has there been a fatal train accident from that cause. The previous such fatal derailment was on July 14th, 1888, so that during forty years there has been only one case in which passengers lost their lives because of the failure of a carriage axle. We would add that on the present occasion there was neither loss of life nor serious personal injury.

DURING the remarkably severe snowstorm at Christmas the normal route of the Harwich boat train of the London and North-Eastern Railway from Sheffield was blocked by snowdrifts. As a consequence that train, on December 26th, had to be diverted *viâ* Newmarket and Bury St. Edmunds. It, however, came to grief in a snowblock at Saxham. When the train came to a stand the guard first went to the signal-box to report what had happened and to receive instructions and then proceeded to protect his train. Meanwhile a light engine had arrived at Higham, the next station in the rear, and as block communication had failed owing to the telegraph wires being down, the light engine was stopped and its driver warned. That man proceeded with caution, but seeing the home signal at Saxham "off"—because it, too, was snow-bound—he kept on running and collided with the standing express, which he was unable to see. Very little damage was done, but unfortunately the driver of a following passenger train, though warned, did not travel with the same caution as the driver of the light engine, and so his train ran into the double obstruction. The circumstances were inquired into by Lieut.-Colonel Mount, whose report thereon has recently been issued. Therein the guard of the first train was blamed for not at once going to protect his train and the driver of the following passenger train criticised for not travelling with greater care. The fireman of the light engine showed great determination under very trying circumstances and for that Colonel Mount congratulated him.

Notes and Memoranda.

IT is claimed that the ropeway which is to be constructed from the Amiamthus mine to the main line of railway to Lourenco Marquez, will be one of the most ambitious schemes of the kind in South Africa. It will be seven miles long, have to cross some high mountains, and is to cost £30,000.

WHAT is considered to be a record run on a paper-making machine was made last month on No. 1 machine in the Thunder Bay paper mill plant, Port Arthur, Ontario. This machine started at 9 o'clock on a Monday morning, and until 11.40 on the Wednesday night it did not stop, nor had a break occurred in the paper.

ON the occasion of the opening of the new recreation grounds of Geo. Salter and Co., Ltd., West Bromwich, which took place on Saturday, May 5th, there were present as many as forty-two employees who have been with the firm for over fifty years. The aggregate service of these members amounts to 2252 years, which represents an average of 53½ years for each individual.

TIN compounds are used in the purification of water in some of the continental towns, using the Linde and Hess process. The water to be purified is filtered through materials impregnated with tin oxide, which is claimed to function as an extremely energetic oxygen carrier and to effect the rapid oxidation of the organic impurities through the agency of the dissolved oxygen present in the water.

FROM *Industrial Gases* we learn of what seems to be a novel use of dissolved acetylene. It is in the heating of the bulbs of Diesel type internal-combustion engines on starting. In the case mentioned acetylene is used for other purposes, and it is piped to the engines, and the necessary blowpipes are permanently installed. It is said that each blowpipe requires 3 cubic feet of acetylene per hour, and gets a cylinder ready for starting within twelve minutes.

THE generating plant in the Lokawei Station of the French Tramway Company in Shanghai is all driven by Sulzer two-cycle Diesel engines, comprising two of 1500 B.H.P., two of 5750 B.H.P., and one of 5250 B.H.P. Just recently a further 3250 B.H.P. Sulzer Diesel engine has been ordered, and will be installed in the same power station. When this new engine is running the normal capacity of the entire plant will be 23,250 B.H.P., with an overload capacity of about 26,000 B.H.P.

A NOTE in *Engineers and Engineering*, of Philadelphia, describes a flexible form of bolt evolved by the American Cable Company. The stalk of these bolts is formed by a length of wire cable, of which five strands are preformed into helices, so that the cable can be cut off into any convenient lengths without fear of fraying. Appropriate lengths of this cable are cut off and fittings are "processed" on to the ends to form heads and threaded ends for the nuts. The processing appears to be a matter of squeezing the fittings into the interstices of the cable.

IT is very desirable, says the Engineer Surveyor-in-Chief to the Board of Trade, in connection with the explosion of a blow-down tank in an Essex boiler plant—and we fully endorse his dictum—that blow-down tanks should not be closed tanks, but where it is not practicable to provide open tanks or sumps the closed tanks should be of sufficient capacity and have pipe connections so arranged that the tanks are not completely filled when in use; that is, the outlet pipe should be of ample area, more of the character of a weir and connected with the tank well below the level of the top. In any case it is essential that the outlet pipes should be kept free from obstruction.

THE Birmingham Tame and Rea District Drainage Board—which has, according to the *Chemical Trade Journal*, one of the largest sewage disposal works in the country—installed last year a plant for making practical use, for power purposes, of the gas which is given off by the sludge from the sewage. The experience gained shows that this plant will produce yearly half a million units of electricity. As its present power requirements are likely to be increased within the next three years from 1,290,000 units per annum to 2,500,000 units, the Board has decided to install a new 400 horse-power engine with the necessary collectors of the sewage gas and an alternator at a cost of £18,000. This plant will, it is stated, produce annually one million units of electricity.

DATA obtained in a study of the propagation of flame in complex mixtures, conducted by the American Bureau of Mines, have made it possible to predict the inflammability of any mixture of hydrogen, carbon monoxide, and methane with varying proportions of oxygen, carbon dioxide and nitrogen from a simple analysis of the mixture. The results are of considerable value in connection with mine fires, and in many industrial operations where inflammable mixtures may be present. The inflammable limits of the complex mixture are calculated from the data obtained for the individual gases. Comparison between calculated and observed values has been made on a series of synthetic gas mixtures, including typical blast-furnace gas, automobile-exhaust gas, gases from detonation of explosives in coal mines, gases after coal-mine explosions, and mine-fire gases. Calculated and observed values for inflammable limits check within 1 per cent.

THE first 220,000 volt step-down transformer station in Canada is now being built by the Hydro-Electric Power Commission of Ontario at Leaside, a suburb of Toronto. This is the receiving end for power being transmitted over 200 miles from the Gatineau power project at Paugan Falls, on the Gatineau River, north of Ottawa, in the Province of Quebec. The transmission line has been under construction since last autumn. The new transmission station when completed will be one of the largest single stations on the continent. The site covers 12 acres, and the battery of transformers will be of the largest practicable size. The buildings will be of brick and concrete with structural steel framework. The manufacture of the electrical equipment is well under way at factories in Peterboro, Toronto, Hamilton and St. Catharines, and the structural steel is being fabricated at Toronto and Walkerville. The progress schedule requires the first portion of the station to be ready to receive power by October 1st, 1928.

Miscellanea.

A NITROGEN fixation factory is to be put up in connection with the Dutch State Mines at Limburg.

WORK is about to be started on one of the first mining operations in the Province of New Brunswick, where some copper deposits have been prospected at Goshen, in Albert County.

THE Australian Government has ordered thirty-four Moth aeroplanes for the Air Force. Twenty are to be constructed in Great Britain, and the remainder, except for their engines, are to be built in the Commonwealth.

DURING the three months ended February, 1928, 60,128 motor vehicles were registered for the first time in this country, including 33,633 cars taxed on horse-power, 16,139 motor cycles, 7925 motor goods vehicles, and 1461 motor-hackneys.

A COMPANY has been formed in Winnipeg for prospecting for minerals in Northern Canada from the air. It has ordered five large aeroplanes capable of carrying six passengers over a maximum radius of 2000 miles and three smaller machines for 500-mile cruises.

A SERVICE of aeroplanes has been organised by the Canadian Pacific Express Company for expediting the delivery of overseas mails by taking them off the incoming steamers at Rimouski, near the mouth of the St. Lawrence, and flying to Quebec, Montreal, Ottawa and Toronto.

THE Board of Trinity House has decided to invite six members of the shipping industry, to be drawn from various classes of shipping and shipping centres, to join in conference with representatives of the Board of Trinity House, under the chairmanship of the Deputy-Master of Trinity House, to consider lighthouse questions administered by the corporation.

THE new power station at Imatra, Finland, is now approaching completion, and it is expected that it will be possible to supply electric energy from the new installation this year. The capital already invested in the station is said to be 370 million F. marks. It is also expected that steps will shortly be taken towards preparing a scheme for the electrification of the railways or at least some of them.

ACCORDING to Mr. M. Kissel, Chief Electrical Engineer of the Public Works Department, New Zealand, the ratio of consumers to population in the supply areas has increased from 10·8 per cent. in 1920 to 20·1 per cent. in 1927, while the consumption per capita has increased from 148 to 310 units per annum. That rate of consumption places New Zealand sixth on the scale of electrified countries.

DURING last year the bascules of the Tower Bridge across the Thames were raised for the passage of vessels on 5372 occasions, the average daily number being fourteen. Land traffic was suspended on these occasions for periods ranging from two to twenty minutes. The cost of maintaining the Tower Bridge and its approaches for the year was £25,612, and was met out of the funds of the Bridge House Estates Committee of the Corporation.

THE scheme for providing San Francisco's new water supply necessitates the construction of an aqueduct 156 miles long, which will run under the Bay of San Francisco, under two ranges of mountains, and will cross miles of open plain. To carry the aqueduct through the mountains it will be necessary to build 28 miles of concrete tunnel. So far only 21 miles of this pipe line have been laid, and it will take another five years before the whole scheme is completed.

IT has been proposed to extend harbour facilities at Newchwang, to afford an outlet for freight transported over the new Chinese lines in Manchuria. A plan is being drawn up to build wharves to berth vessels of various sizes and to construct a new town for railway freight dealers. It is also planned to open an exchange, banks, and trading establishments near the North Side Station. The sum of £50,000 has been appropriated for the immediate improvement of the port. A new bund is to be built along the shore front about two-thirds of a mile in length. All construction work is to be undertaken by the Peking-Mukden Railway.

A MESSAGE from Santiago states that considerable progress has been made with the works in connection with the concession granted by the Government to the Sociedad Carbonifera do Brazil, a Chilean coal-owning company with valuable mines at Marfil, in the Province of Valdivia. The concession, which is for fifty years, calls for the erection of an additional steam-generating station and of several high-tension lines, sub-stations and other units at Marfil. The company, which can now produce 2000 H.P. above the requirements of the mine, has further raised its capital to 3,200,000 pesos, which has been subscribed wholly by local interests.

ACCORDING to a statement issued by the National Federation of Iron and Steel Manufacturers, the number of furnaces in blast at the end of April was 149, a net decrease of one since the beginning of the month, three furnaces having gone into blast and four having ceased operations. The production of pig iron in April amounted to 555,000 tons, compared with 592,600 tons in March and 680,000 tons in April, 1927. The production included 186,200 tons of hematite, 184,000 tons of basic, 142,700 tons of foundry, and 22,600 tons of forge pig iron. The production of steel ingots and castings in April amounted to 644,100 tons, compared with 793,300 tons in March and 850,100 tons in April, 1927.

As an initial step to the proposed expansion of the work of the National Research Council of Canada, Dr. Henry Marshall Tory, President of the University of Alberta, has resigned that position and accepted the appointment of President of the National Research Council. The new laboratories to be erected in Ottawa this season at a cost of 750,000 dollars, will combine the functions of the Bureau of Standards of Washington and the Mellon Institute at Pittsburgh. When they have been established it will be possible for the Council to carry on national standardisation and research service similar to that undertaken in other important industrial countries. The programme contemplates the expenditure of 3,000,000 dollars, spread over a period of ten years.

AVONMOUTH DOCKS, EASTERN ARM EXTENSION

(For description see page 539)

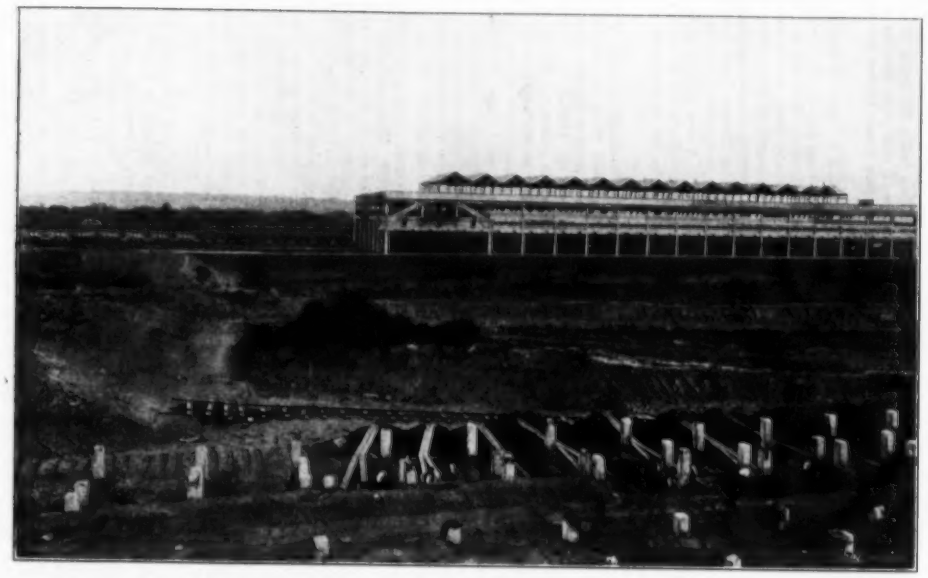


FIG. 7—SHED "V" AND PART OF EAST WHARF

FIG. 8—GENERAL VIEW OF EASTERN ARM FROM NORTH END

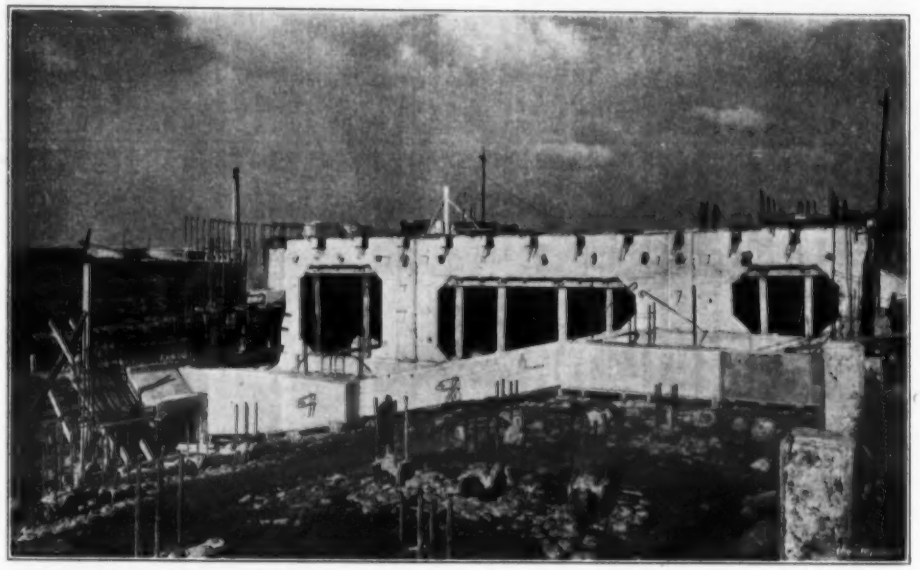


FIG. 9—SECTION OF WHARF AND REINFORCED CONCRETE FRAME

FIG. 10—PILE DRIVING IN PROGRESS

STONEWARE PIPE WORKS OF DOULTON AND CO., LTD., AT ERITH

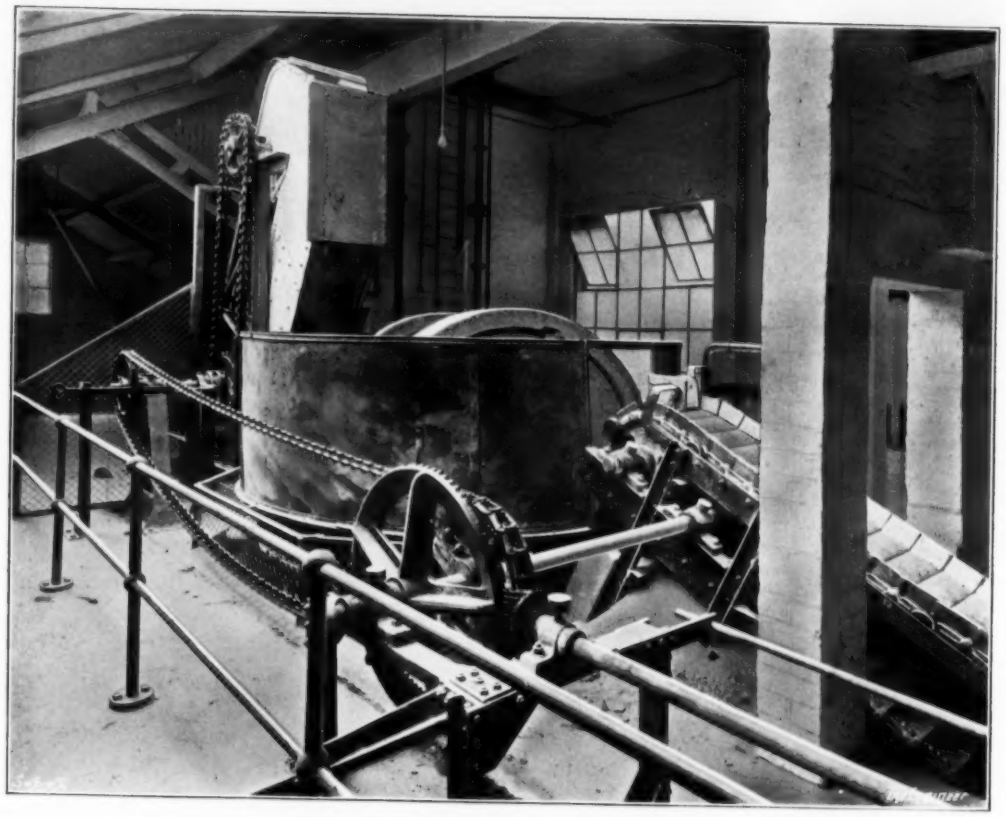


FIG. I.—TOP PAN OF MAIN GRINDING MILL

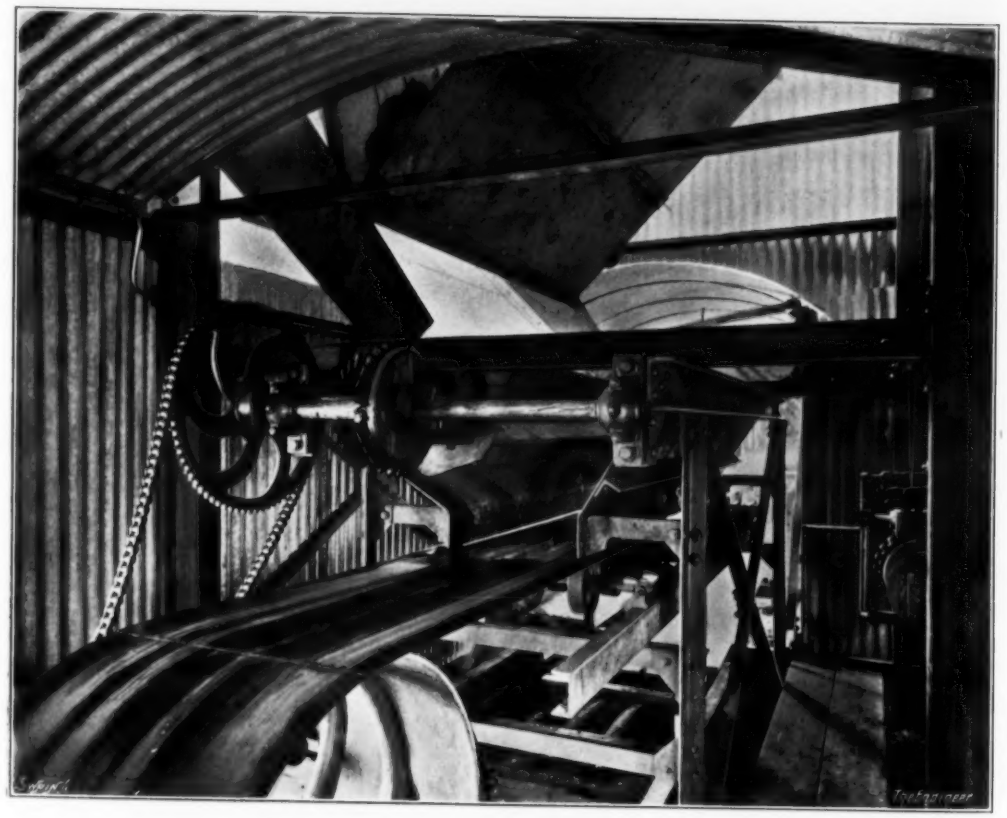
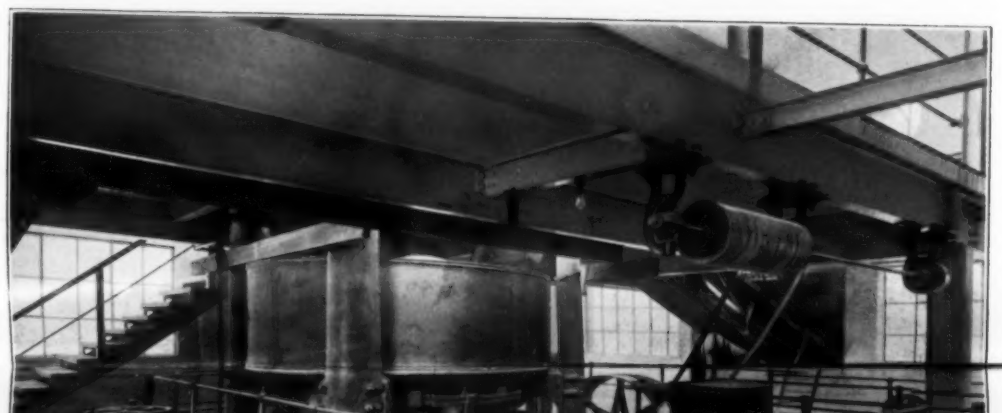


FIG. II.—FEEDING END OF MAIN MATERIALS CONVEYOR



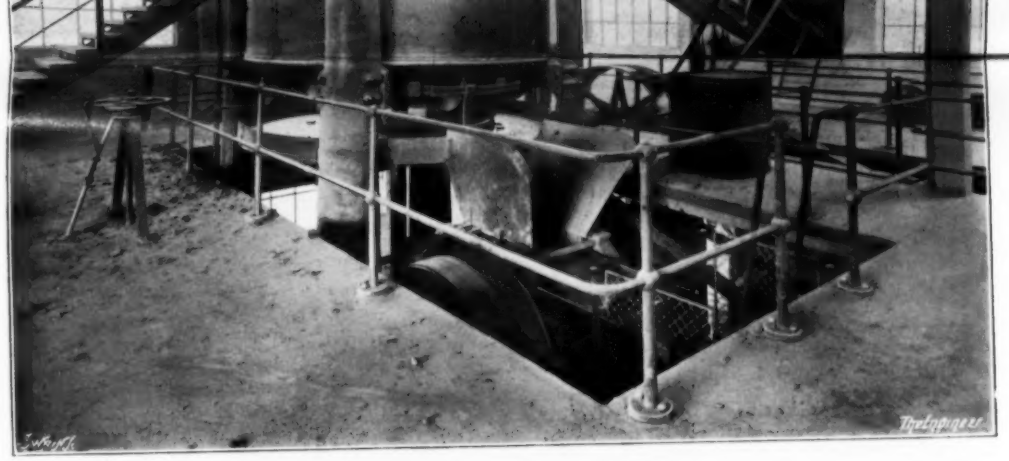


FIG. III.—SECOND PAN AND FINE-GRINDING MILL

FIG. IV.—TRANSFER STATION—MAIN CONVEYOR

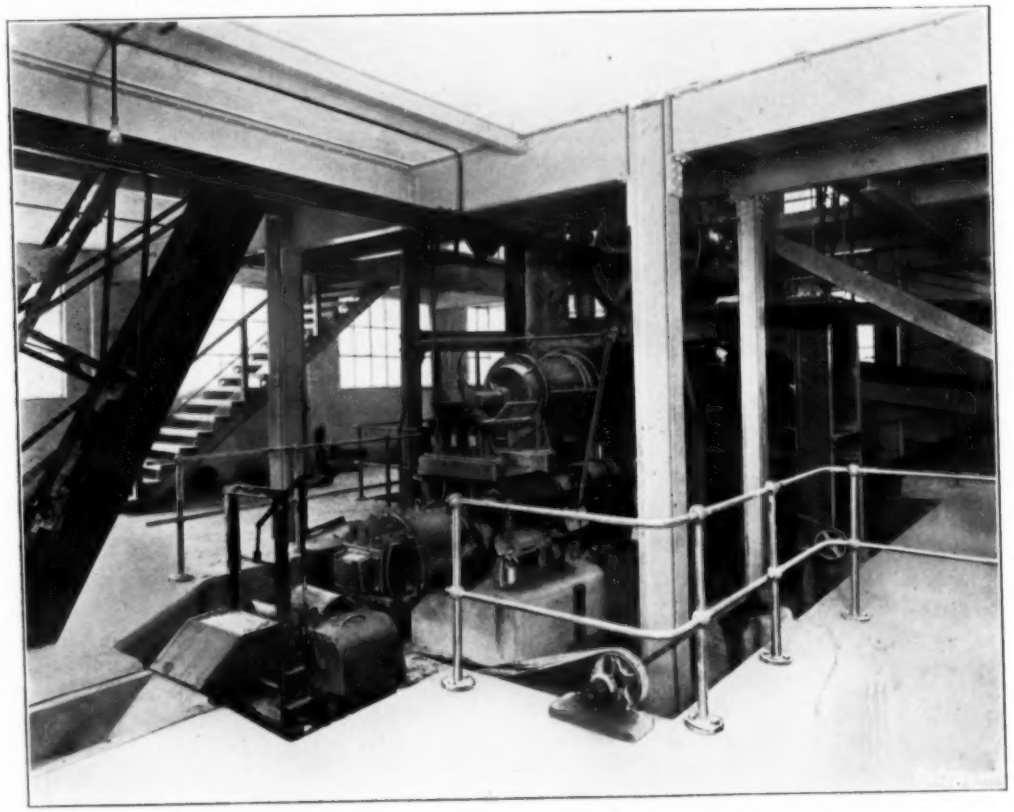


FIG. V.—PUG MILL AND CUT-OFF ON GROUND FLOOR

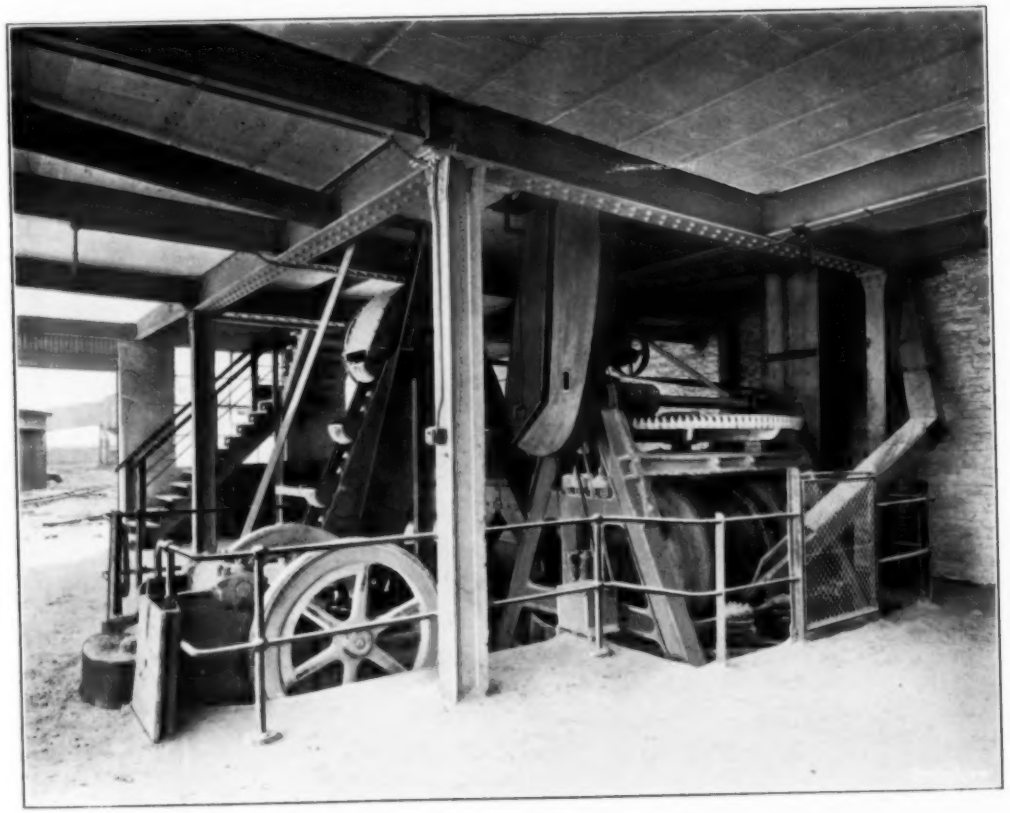


FIG. VI.—GROG CRUSHER AND GRINDING MILL

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THE ENGINEER.

MAY 18, 1928.

The Spanish Navy.

In 1908, ten years after the disastrous war with the United States, a strong Spanish Government applied itself with energy to the task of rehabilitating the national naval forces, which at that time had sunk into a state of virtual impotence. A systematic programme of construction extending over a period of many years was drafted by Admiral Ferrandiz, Minister of Marine in the Maura Cabinet, and after prolonged debate was adopted as it stood. It provided, *inter alia*, for nine capital ships, which were to be built and renewed by series of three in a span of time not exceeding twenty-five years, as well as for the early construction of three destroyers, twenty-five torpedo boats, and some gunboats. No time was lost in giving effect to this important piece of legislation. The first three capital ships were all begun between 1909 and 1912, as were the smaller craft, and the whole programme would have been executed with a promptitude foreign to Spanish tradition had not the Great War intervened. From 1914 onward building operations were seriously retarded by the difficulty of obtaining material and equipment, heavy contracts for which had been placed in this country. Shortly after the passing of the programme the principal dockyard at Ferrol was taken over by La Sociedad Española de Construccion Naval, in which three British firms—Sir W. G. Armstrong, Whitworth and Co., John Brown and Co., and Vickers—had a financial interest, theirs being the only foreign capital invested in the company. In addition to financial aid the British firms in question supplied all the drawings and technical data required for the new battleships, cruisers, and destroyers. Under their supervision the dockyard at Ferrol was reorganised and equipped for modern construction. At one time no less than 300 British officials and engineers were employed at this establishment, out of a total staff of 3000. As a result the vessels built under the programme were up to the highest standards in design and workmanship. The three battleships were constructed to a uniform plan, the features of which were powerful armament, reasonably good protection, and fair speed, on the remarkably modest displacement of 15,452 tons. As each of these comparatively small vessels could train eight 12in. high-velocity guns on the beam, had its vitals protected by 8in. to 10in. armour, and could steam at 19·5 knots, the degree of skill exhibited in their design is self-evident. Of this trio the "Alfonso XIII." and the "Jaime I." are now performing useful service, but the name-ship of the class, "España," was unfortunately wrecked off the coast of Morocco some five years ago.

In February, 1915, the original programme was amplified in the light of what was then happening in the North Sea and elsewhere. The Government obtained authority to build four cruisers, six destroyers, and twenty-eight submarines, to improve the naval bases at Ferrol, Cadiz, and Cartagena, and to create new depôts for the fleet in the Balearic Islands and the lower Rias of Galicia, all of which undertakings were to be completed within six years. Difficulties of supply made it necessary to prolong this period, but with the exception of certain submarines all the vessels specified have been completed, together with some additional units. In consequence of this vigorous and sustained policy of development the Spanish Navy has now attained a position of relative strength such as it has not held for several generations. Its principal vessels, if limited in number, are mostly of an up-to-date and powerful type. It has cruisers that compare very favourably with anything we possess below the "County" class, torpedo craft of great speed and formidable armament, and a flotilla of first-class submarines. But the process of expansion is not yet complete. A new programme of construction which had been under consideration for two years was approved last week at a Cabinet meeting attended by the King. It involves an expenditure of about £20,000,000, the greater part of which will be disbursed within the country itself, as the official announcement states that "the ships will all be built in Spain, thus helping to improve the national industry and make it capable of undertaking more important enterprises." The vessels projected include three cruisers of the "Washington" class, each of 10,000 tons, six large flotilla leaders, and twelve submarines, and a number of minelaying and auxiliary craft. Furthermore, it is stated, though not yet confirmed, that two battleships are to be laid down. They will be reduced versions of the British "Nelsons," displacing about 25,000 tons, with an armament of six or eight 16in. guns. Vessels of this formidable type would unquestionably add to the power and prestige of the Spanish Navy, and in spite of the high cost their construction would appear to be a sound stroke of policy. It seems doubtful whether the existing facilities at Ferrol dockyard would suffice for the building of such large ships. If they should be laid down, their design will probably be profoundly influenced by British practice, as in the case of the fine Spanish cruisers and destroyers which have recently passed into service. The official *communiqué* on the new naval programme emphasises the necessity of Spain holding at sea "a rank which befits her geographical situation and economic strength." It is added that she is in no sense inspired by an Imperialist policy, but she "cannot neglect to provide for her defence, and must be able to figure among the naval forces of the world as a fact or worthy of being taken into account." Even at its present strength the Spanish Navy is far from being a negligible quantity. Besides the two small but powerful 12in. gun battleships and irrespective of five old cruisers that might be of use for subsidiary duties, it contains five cruisers of modern construction, ten modern flotilla leaders and destroyers, and sixteen submarines. The *personnel* numbers approximately 12,000 officers and men, the majority of whom are drawn from the coastal districts. No difficulty is experienced in obtaining the 4000 recruits who are required each year to maintain the establishment at strength, since from the seafaring population alone the annual quota of men who become liable for military service is at least 15,000. Although Spanish industry is, at present, by no means capable of supplying all the material requisite for the construction of a first-class navy, it is making definite strides in that direction. The output from the steel foundries at Reinosa is increasing year by year, and a considerable part of it has been already embodied in the new warships. Both at Reinosa and at Carraca (Cadiz) there are well-equipped shops for the manufacture of guns up to a calibre of 6in., and it is hoped in future to turn out still heavier weapons. These arsenals together have provided the entire armament of the latest cruisers. It is not surprising to learn that the adoption of the new programme

has caused rejoicing alike in the dockyard districts of Ferrol, Cadiz, and Cartagena, and in the industrial districts throughout the country, all of which will benefit to a greater or lesser degree. Marked attention is being paid to aviation as an auxiliary arm of the naval service. The "Dédalo," a converted merchant steamer of 10,800 tons, has been in commission for some time as an aircraft carrier, and proved exceedingly useful during the recent amphibian operations against the Rifi tribes. A large naval aerodrome has been laid out at Barcelona, where officers and men are trained for service in aeroplanes and dirigibles. It is the desire of the naval authorities to create by degrees a chain of aircraft bases along the Atlantic and Mediterranean coasts.

It is but natural that this steady growth of the naval power of Spain, having regard to her geographical position, should be exciting interest in Paris and Rome. Even in this country we should do well to take note of it, not as a potential menace, but as a factor which is bound to exert a perceptible influence on the balance of power in European waters. France, keeping a vigilant eye on her vital communications with Northern Africa, exhibits perturbation at the development of Spanish strength in swift cruisers, torpedo craft, and submarines and sees in the Balearic Islands an ideal base from which an enemy could strike at the traffic routes on the integrity of which the fate of France might depend in a future war. Italian politicians, on their part, perceive in the expanding Spanish Navy a valuable counterweight to French naval power, and from time to time throw out hints as to the desirability of a maritime *entente* between Italy and Spain. We are not concerned with these political speculations except in so far as they furnish a new object lesson on the value of sea power. The Spanish Government has been rebuked in some quarters for spending so much money on its naval forces, but it is assuredly not a coincidence that the voice of Spain is now heard with increasing respect in the councils of Europe. The British people, bound as they are to Spain by the ties of long-enduring friendship, watch with sympathy and admiration her stalwart efforts to regain a measure of naval strength consistent not only with her dignity and traditions, but with her actual responsibilities. It is a pleasant reflection that British science and business enterprise should have been granted so large a share in the work of reconstruction.

Electrical Breakdowns in 1927.

IN the April issue of *Vulcan*, the well-known quarterly journal of the Vulcan Boiler and General Insurance Company, an interesting analysis is made of breakdowns of electrical plant during 1927. While there were many more faults on direct-current armatures than there were on squirrel-cage rotors, the total cost of repairs to direct and alternating-current motors was divided in the proportions of 51·2 and 48·8 per cent. respectively. Slip-ring machines, and in fact commutator machines, naturally also come within the category of alternating-current motors. Although wound slip-ring rotors accounted for many more breakdowns than squirrel-cage rotors, our contemporary apparently considers that the reliability of the squirrel-cage motor has been exaggerated. Incidentally, alternating commutator motors, which are not, of course, employed to any appreciable extent in this country, are not referred to at all. The arguments adduced to support the view that alternating-current motors are less liable to breakdown than direct-current motors is believed to be largely based on a comparison between the construction of the squirrel-cage rotor and the direct-current armature, which during the period reviewed accounted for 57 per cent. of the repair cost of this type of machinery, as against 11·6 per cent. for the simple rotor with bars and end rings. One of the tables accompanying the article shows, however, that 68 per cent. of the breakdowns on squirrel-cage motors were due to stators, and that these breakdowns accounted for 80 per cent. of the cost of repairs to these motors. Rotors, shafts, starters, bearing and miscellaneous faults accounted respectively for 11·5, 2·5, 11·5, 4·5, and 2 per cent. of the breakdowns to squirrel-cage machines. A similar table relating to slip-ring motors shows that the stators accounted for 28 per cent. of the total number of breakdowns, rotors 31, brush gear 12, shafts 3, starters 16, bearings and miscellaneous troubles 6 per cent. The tables indicate that whilst the stator is the weakest part of the squirrel-cage motor, the rotor most frequently comes to grief in the case of the slip-ring machine. The weakest part of the direct-current motor is, of course, the armature, which accounted for 43 per cent. of the total number of breakdowns of this class of machinery and gave rise to 60·6 per cent. of the total cost of repairs.

The desirability of making the squirrel-cage motor stator winding more robust was referred to by Mr. W. E. Rogers in the course of the discussion on Mr. Hoseason's paper, to which we have recently alluded. "What," he said, "is the virtue of an indestructible rotor when it has to work in conjunction with a destructible stator. We still depend on double cotton-covered wire, plus leatheroid and empire cloth, but possibly stator weakness may be partially eliminated when the recent French process of bakelite impregnation is further developed, as it is claimed that a motor submerged in water has been run at a temperature of 300 deg. for a lengthy period." During the same discussion Mr. T. Carter remarked that the rotor had become vastly stronger than the stator, and if conditions gave rise to overheating it was the stator that suffered, and he sometimes wondered if the indestructible rotor was actually an advantage. Conditions giving rise to undue heating occurred when one of the phases of the three-phase supply was open-circuited and when the motor went on running for some time with only two lines connected to the stator. Formerly the rotor joints gave out, but they were now too strong, and the stator winding failed. Replying to these points, Mr. Hoseason said that from the war period onwards failures of squirrel-cage rotors had practically disappeared, but there had been no corresponding increase in the failure of stators. Possibly the use of magnetic trips in starters, instead of fuses, had influenced the position. Incidentally, Mr. Hoseason gave in his paper figures taken from the Technical Report of the British Engine, Boiler and Electrical Insurance Company for 1922, showing that at that time 63 per cent. of the breakdowns on machines were on armatures, commutators, slip rings and brush gear, and these figures were considered to indicate that the squirrel-cage motor had a "probability of breakdown" of about 45 per cent. of that of electrical machines in general. Given proper protective gear, squirrel-cage motors should prove very reliable, notwithstanding that the stator is not indestructible. Figures covering the cost of maintaining all types of alternating-current motors cannot give a true indication of the behaviour of squirrel-cage motors, some of which, according to Mr. J. S. Peck, have been in successful operation for thirty years. That the stator windings of these motors are now the weakest part the figures published in *Vulcan* clearly show, and manufacturers should now endeavour to see what they can do to improve these windings, even if they run the risk of producing machines that will never require renewing.

A fact brought to light by this analysis of electrical breakdowns during 1927 is that there was an increase in the percentage number of claims on the Vulcan Boiler and General Insurance Company as compared with the preceding year. Although the reason for this is at present more or less a matter of conjecture, it is thought that in all probability the increase in the number of breakdowns was very largely the aftermath of the general strike and of the coal stoppage, accentuated by abnormal weather conditions. When electrical machinery is allowed to stand idle, even when it is under cover the windings and other parts may gather a certain amount of moisture, and if a machine is put to work in this condition the insulation is liable to fail. Many users of electric power, however, do not appear to realise that trouble of this nature is liable to arise, and that if machines have become damp as the result of weeks or months of idleness they should be dried out before they are set to work. The weather affected the returns, not alone by its excessive humidity, but also in many districts by disastrous floods which led to machines being submerged; apparently some of them were restarted without being first thoroughly dried out. Many so-called electrical contractors who are called in upon these occasions do not know their job, and consider that the best thing to do is to place fires in the vicinity of the motors, which derive little benefit therefrom. The incompetent electrical contractor still seems to be responsible for a good deal of trouble, which qualified electrical engineers could easily avoid, and it is somewhat remarkable that in these days, when so many capable men are available, he should continue to survive.

THE parliamentary Bill authorising the construction of a tidal power plant in Passamaquoddy Bay, New Brunswick, has been passed by the Legislature.

Literature.

The Working of Unstratified Mineral Deposits. By GEORGE J. YOUNG, M.I.M.E., Associate Editor of the Engineering and Mining Journal Press. Ernest Benn, Ltd., London.

THIS volume is one of the series of mining books published by Benn, Ltd., under the editorship of Emeritus Professor Henry Louis, M.A., D.Sc., and, as the title indicates, deals with one of the important branches of mining—the working of unstratified mineral deposits. It is, without doubt, an excellent treatise of which mining engineers will make much use. A considerable proportion of the book deals with descriptions taken from other works, but the author has in no way allowed his personal preference for any one particular method to bias his judgment, rather he has emphasised the importance of the experience gained by others, in any special sphere or branch of work.

Chapter I. covers types of Ore Deposits and General Considerations. In connection with working ore at great depth the author is of the opinion that probably the chief limitation upon depth of mining is the value of the ore as compared with the cost of its extraction, and in the latter the actual mining plays an important part.

The Mechanics of Rock Masses dealt with in Chapter II. and the Classification and General Features of Mining Methods in Chapter III., are to be commended. It is common knowledge that measurement of rock pressures is seldom done in mining practice, and we agree with the author that valuable information might be gained if it were carried out. In this chapter the remarks on supports and methods of working are very sound, and the sketches and diagrams are excellent.

Chapter IV. is devoted to the Mining of Narrow and Intermediate Sized Veins, and describes the ordinary methods of working, whilst references to various modifications which have been adopted to meet the requirements of special cases are valuable additions.

A comparison is made in Chapter V.—"Mining of Wide Ore-bodies of the Vein Type"—of the different processes of mining with respect to the dip of the ore-body and the physical nature of the walls and ore mass. The important advantages that have been derived by the application of particular methods are carefully noted. In the Mining of Large Ore-bodies, Chapter VI., the methods are skilfully classified and aptly illustrated, whilst the author's reasoning on the precautions to be taken in shrinkage stoping, may be studied to advantage. The doubling of output by substitution of mechanical for hand loading is decided proof of the value of mechanical appliances. The summarisation of various methods and the sound advice regarding costs and schemes of mining which are incorporated in this chapter render it highly instructive.

Mining Tools and Underground Structures are described in Chapter VII., and the account of the author's own experiences concerning drill bits is valuable. The standardisation of timber sizes and pieces for a given method of mining is recommended, thus enabling the advantageous utilisation of special machinery and facilitating mass production in the timber-framing shops.

The concluding chapters offer much sound advice, and throughout the volume problems that are encountered in exploiting the various deposits are efficiently handled and difficulties clearly explained by the aid of carefully selected examples supplemented by excellent diagrams.

BOOKS RECEIVED.

The Journal of the Institution of Engineers (India). Calcutta: The Institution of Engineers (India), Post Box 669, India.

Riemenschlupf und Reibungszahl von Gummi und Ledertreibriemen. Dipl.-Ing. Hans Nowsky. Berlin. 1927. R. Oldenbourg.

Cours de Mécanique. By Paul Lévy. Paris: Gauthier-Villars et Cie. Quai des Grands-Augustins 55, France. Price 50 francs net.

Steam Condensing Plant. By J. Evans. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 7s. 6d. net.

The Engineering Index, 1927. New York: The American Society of Mechanical Engineers, 29, West 39th-street, N.Y., U.S.A. Price 8·50 dollars.

Verzeichnis Berechneter Functionentafeln. Part I.: Besselsche, Kugel, und Elliptische Functionen. V.D.I., Berlin and the University of Berlin.

The "Electrician" Annual Tables of Electricity Undertakings, 1928. London: Ernest Benn, Ltd., Bouverie House, 154, Fleet-street, E.C. 4. Price 10s. net.

Die Bestimmung der Baustoffdämpfung Nach dem Verdrehungsausschwingverfahren. Ewald Pertz. Price 3·50 marks. Fridr. Vieweg und Sohn A.G., Braunschweug.

Traité pratique de Navigation Aérienne. By A.-B. Duval and L. Hébrard. Paris (VI^e): Gauthier-Villars et Cie., 55, Quai des Grands Augustins, France. Price 30f. net.

Annali dei Lavori Pubblici (gia Giornale del Genio Civile). Ministero dei Lavori Pubblici, Consiglio Superiore. 1928. No. 2. Febbraio—VI°. Rome: Provveditorato Generale dello Stato Libreria.

Turbo-Generator at Rotterdam.

No. II. (*Conclusion*).*

THE rotor of the high-pressure cylinder consists of two single-stage impulse wheels with a mean diameter of 1000 mm., followed by ten rows of reaction blading with a mean diameter of 823 mm. All the blading

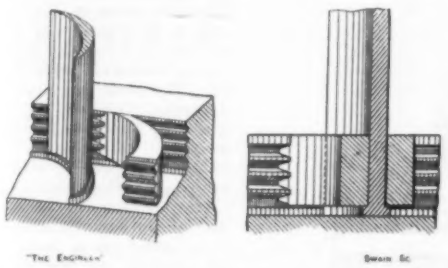


FIG. 12—METHOD OF FIXING REACTION BLADING

in this cylinder is of stainless steel. The reaction stages of the rotor are carried on a drum of Siemens-Martin steel keyed to the shaft. The blading of the intermediate-pressure cylinder is also of stainless steel. The rotor is a steel drum similar in design and material to

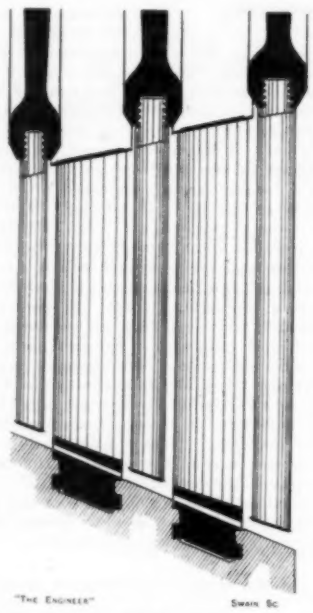


FIG. 13—L.P. REACTION BLADING IN LOWER HALF OF CYLINDER

that of the high-pressure cylinder. It carries twelve running rows of blades with a mean diameter of 1000 mm. The low-pressure rotor comprises ten wheels, each carrying a single row of stainless steel reaction blading. The fixed blading in this cylinder is of brass. The mean diameter of the running blades is 1550 mm. Since the low-pressure turbine really consists of two five-stage sections in parallel, it will be seen that there are altogether twenty-seven reaction stages in the whole turbine. The mean height of the blades in the first two cylinders is 86 mm. and 132 mm. respectively, while the longest blades in the low-pressure cylinder have a height of 370 mm. The wheels in this cylinder and in the high-pressure cylinder are mounted in a simple but effective manner devised by Messrs. Brown, Boveri and Co. As is well known, wheels mounted directly on the shaft tend to become loose at high speeds owing to the stretching of the material under centrifugal force and aided by temperature conditions. Some form of elastic mounting is thus necessary, and this in Messrs. Brown, Boveri's practice takes the form of a pair of U-shaped steel rings with the axis of the U parallel to the axis of the ring, as in a hydraulic packing leather. The wheels are bored slightly larger at the shaft and are counter-bored from each side. Into these counter-bores the rings are forced, with their open sides outwards. The wheel is thus held concentrically and squarely with the shaft with the exact

FIG. 16—GUIDE BLADE SHOWING DRAINAGE GROOVE

degree of tightness required and without any fear of want of balance. Rotation of the wheel is provided against by three feather keys at equal distances round the bore, and the axial location is provided for by a slight step in the diameter of the shaft at each wheel seating.

The reaction blading of both drums and wheels is fixed by distance pieces which engage with serrations turned in the sides of the grooves. Each blade is held positively and firmly by its adjacent distance pieces, their frictional grip not being depended on in any way. The way this is effected will be clear from Fig. 12. The blades are cut from strip of the required section, and each is then upset at its root end by means of a special die. This is done cold. The operation leaves a definite T-shaped flange both on the inside and the outside of the blade, and the distance pieces fitting over these flanges hold the blades against all possibility of rising in the grooves. The blades are not weakened by any notches and, being held evenly before and behind, a symmetrical distribution of the stress due to their centrifugal force is obtained.

There are no diaphragms between the wheels in the low-pressure cylinder, but leakage is minimised by a patented form of shrouding over the tips of both running and fixed blades. This is shown in Fig. 13. The shrouding is of thin sheet brass, still further thinned to a knife edge at the sides. These knife edges project slightly from the faces of the blade rows and run nearly in contact with the roots of the next row of blading on each side. Should they accidentally touch them when running no harm would result, and in any case a reasonable clearance can be left because the density of the steam is so small at this part of the turbine that the quantity which could escape by inter-stage leakage is very small indeed. Fig 13 also shows the passage way left for water to escape from the blading of the low-pressure cylinder. The formation of water is due, of course, to the adiabatic expansion of the steam and cannot therefore be prevented. The injurious effect of its presence, both on the efficiency of the turbine and on the material of the blading, has long been recognised, and special light has been thrown on the subject by the able researches of Dr. Von Freudenreich, the chief of the research department at the works of Brown, Boveri and Co. The running blades tend to throw the water, as formed, against the walls of the turbine. Much of it will run down the walls to the bottom of the casing, and to let it escape without entering the steam flow again Messrs. Brown, Boveri provide the passages, shown in Fig. 13, through the roots of the fixed blading in the lower half of the casing. The fixed blades in this case have roots of the form shown in Fig. 16, which illustrates the two side grooves by which the root is held and the transverse groove, closed by the next blade root, to form a passage for the water.

The alternator has a maximum continuous capacity of 25,000 kVA, or 20,000 kW, at a power factor of 80 per cent. It is wound for 5000 to 5500 volts and a current of 2900 to 2630 ampères per phase. It is a 50-cycle machine, the revolutions, as already stated, being 3000 per minute. The rotor is flexibly coupled to that of the low-pressure cylinder of the turbine at one end, and at the other to the shaft of the ventilating fan, which in turn drives the exciter at the extreme end of the whole machine. The exciter furnishes 370 ampères at 230 volts to the rotor. The construction of the alternator and the arrangement of the fan and exciter were illustrated in the Supplement in last week's issue. Photographs of the stator during assembly are reproduced in Figs. 14 and 15.

The stator frame is of non-magnetic cast iron. To facilitate casting and to keep the dimensions to suitable limits the main body of it was constructed in two parts bolted together with a vertical joint running round its centre. Further, to reduce the dimensions with a view to transportation, the feet by which it is supported at the sides were made detachable, as will be seen by the illustrations. The interior of the frame is divided into a number of chambers, some acting as inlet ducts for the fresh air passing to the laminated core, and alternate ones serving to take the air coming from the core and conduct it to the end windings. A pair of inlet chambers and a section through an exit chamber can be seen in the end views of the alternator given in our Supplement last week. To the inside of the frame are screwed longitudinal dovetailed strips of non-magnetic material which serve to carry the laminations. The latter are made from high-permeability iron and insulated from each other by paper. Distance pieces of angle iron are welded to certain of the laminations and serve to separate the core into a number of sections between which the cooling air can pass. In order to maintain the walls of the conductor slots flat and unbroken throughout the entire length of the core the distance pieces are arranged to coincide with the tooth profile at their inner ends. The core is pressed together axially by end plates of cast iron, to which steel fingers are welded to provide a support for each tooth. These fingers are clearly visible in Fig. 14. They extend radially beyond the core and are welded at their outer ends to the frame. Bolts,

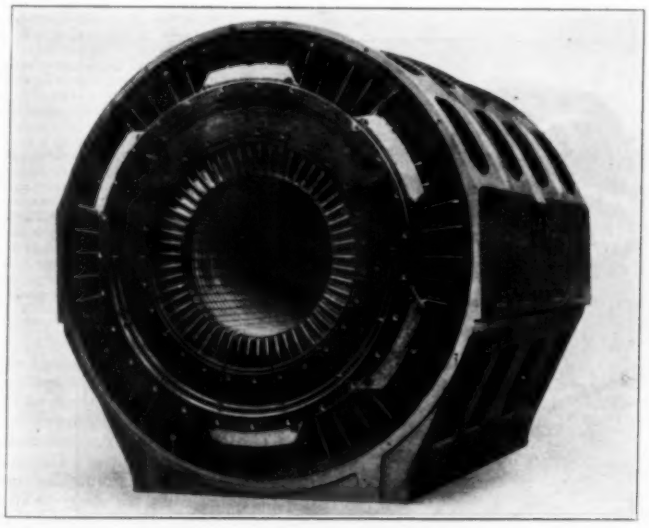


FIG. 14—20,000 kW ALTERNATOR STATOR BEFORE WINDING

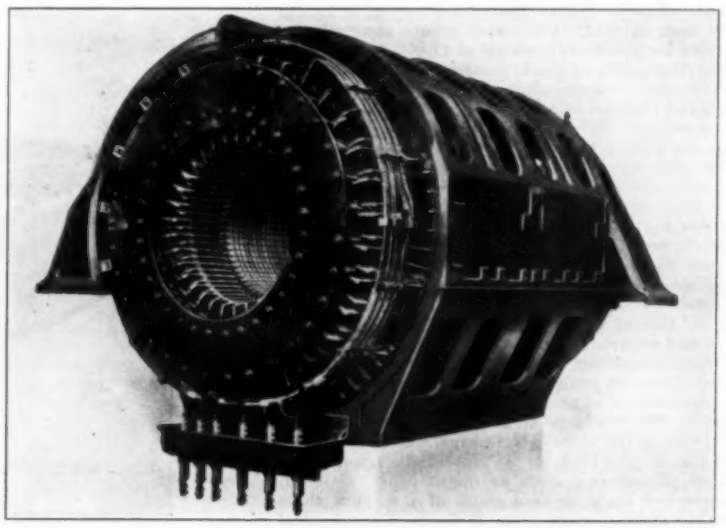


FIG. 15—20,000 kW ALTERNATOR STATOR AFTER WINDING

* No. I. appeared May 11th.

which do not pass through the laminations, hold the core tightly together by means of the cast iron plates mentioned.

The stator slots are considerably deeper than is necessary to carry the windings. The latter lie in the bottom of the slots, which are narrowed for a certain distance from their mouths. This arrangement, it will be realised, permits the stator winding to be distributed over a larger circumference, while the reactance of the magnetic circuit is increased and the teeth are more effectively cooled. The stator winding comprises two multi-strand bars in each slot, a large copper cap being riveted and soldered over the end of each bar. The bars are sufficiently

FIG. 17—TWISTED STATOR CONDUCTOR

insulated one from another, and are twisted as shown in Fig. 17 to avoid the eddy currents which would otherwise circulate in them. The construction is of great simplicity, while possessing all the mechanical and electrical features which are desirable. The end connections are mounted in four layers in a manner permitting good ventilation. The symmetry of the three phases is absolutely assured. The end connections are directly supported by a large number of bolts fitted for that purpose, and the free lengths of the conductor bars are also amply protected against any tendency to movement under the stresses which a sudden short circuit would throw upon them. It may be mentioned that detailed short circuit tests

absence of special air slots or deep grooves for cooling gives the rotor a greater carrying capacity, and also prevents the weakening of the section mechanically. A few small slots are provided in the unwound portion of the rotor for facilitating the passage

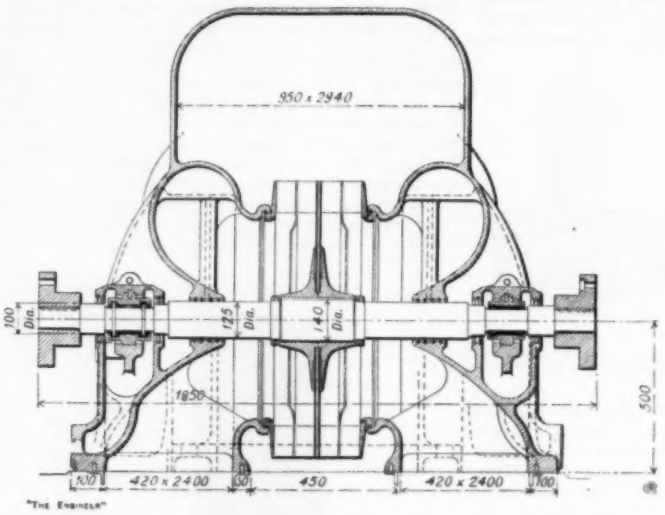


FIG. 20—SECTION THROUGH BLOWER FOR COOLING ALTERNATOR

of the cooling air. The slip rings, which are made of steel, are mounted on the rotor shaft beyond the bearing, the connections from them to the windings being taken through the hollow shaft.

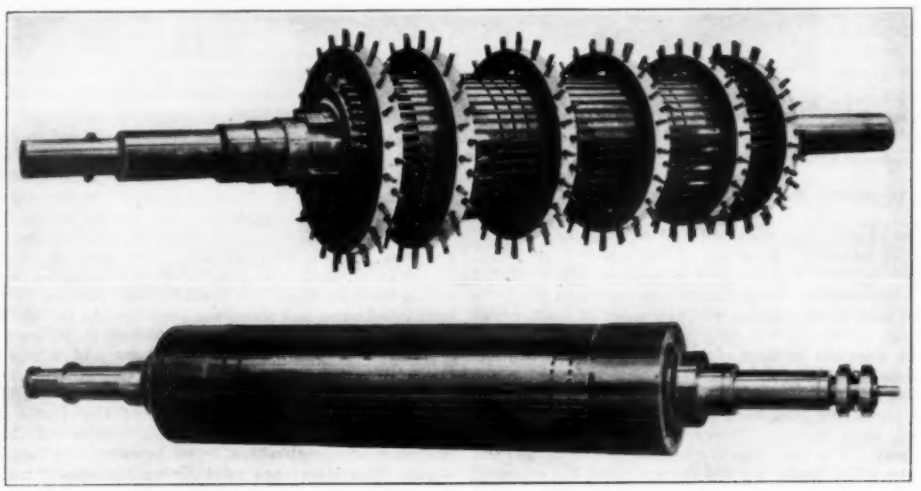


FIG. 18—ROTOR DURING CONSTRUCTION

FIG. 19—ROTOR FINISHED

were actually carried out in the works of the makers, and the results showed the method of construction to be satisfactory in every way. The winding was further subjected to a pressure test of 25,000 volts before shipment, although the working pressure would not exceed 5500 volts. The test pressure of 25,000 volts was, in fact, that which would generally be specified for machines working at 11,000 volts.

The rotor, with its shaft, is made from a single forging. To verify the soundness and quality of the metal, it is bored through from end to end, with a hole about 3in. diameter. The slots for the winding are milled from the solid. The winding is of copper strip laid in the slots layer on layer, with micanite as insulating material and distance pieces of prepared asbestos. After being placed in the slots the winding was pressed together by means of set-screws held in rings which were slipped over the rotor. While being pressed in this manner the complete winding was heated electrically and the screws "followed up" from time to time. That is the general practice of Messrs. Brown, Boveri and Co., as regards rotors of this type, and experience shows that windings so treated do not move either in service or in overspeed tests, so that the rotors run at all times exceptionally quietly. The appearance of the rotor during the operation of pressing the windings is shown in Fig. 18, while Fig. 19 shows the rotor in its finished state. A damper winding is provided as a protection against undesired phenomena, such as might occur with unsymmetrical loads, or as a result of a sudden short circuit. At the same time, it forms a mechanical protection for the main winding when the end caps are removed. The latter hold the heads of the coils, the part of the winding embedded in the rotor being secured by dove-tailed metal keys. The end caps are of a special grade of non-magnetic steel, of sufficiently good quality to permit of circumferential speeds as high as 145 m. per second being employed. Such speeds have indeed been used now for some years. The rotor is cooled principally at its surface. The

Cooling air for the alternator is supplied by a blower coupled to the rotor shaft as already mentioned. The capacity of this blower is 30 cubic metres per second. The air is forced round a closed circuit, passing first through the cooler and thence to the two end shields of the alternator. The cold air is distributed uniformly over the end windings, and having passed through them it enters the stator frame by a number of chambers, two of which are seen in the Supplement referred to above. From these it enters the stator core some of it passes down radially through the core to the air gap, and back through similar passages to the inside of the stator frame, and some reaches the inside of the frame through ports between the laminations which do not lead to the air gap. The nature of the passages between the laminations will be understood by reference to the cross section given in the same drawing. A section through the blower is given in Fig. 20, and a photograph of the rotor in the lower half of the casing is reproduced in Fig. 21. The rotor is 900 mm. diameter, giving a tip speed of about 463ft. per second. Its boss is in halves, between which are riveted the three steel plates forming the central disc of the fan. The boss is mounted on a feather, its position on the shaft being maintained by two nuts, adequate provision being made to secure the nuts in position. A locking piece of metal, 20 mm. wide, is inserted in the end of the keyway of the boss, and the projecting end is bent down to engage with a notch in the nut when the latter is tightened up. The fan blades are narrow, having a radial depth of only 100 mm. They are supported by a guide ring on each side of the central disc, this ring also serving to direct the air flow properly. Air tightness, both around the eyes of the fan and where the shaft passes through the casing, is secured by U-shaped rings, in the positions indicated in Fig. 20. The shaft is located axially by two thrust rings in one of the bearings, as will be seen in the drawing.

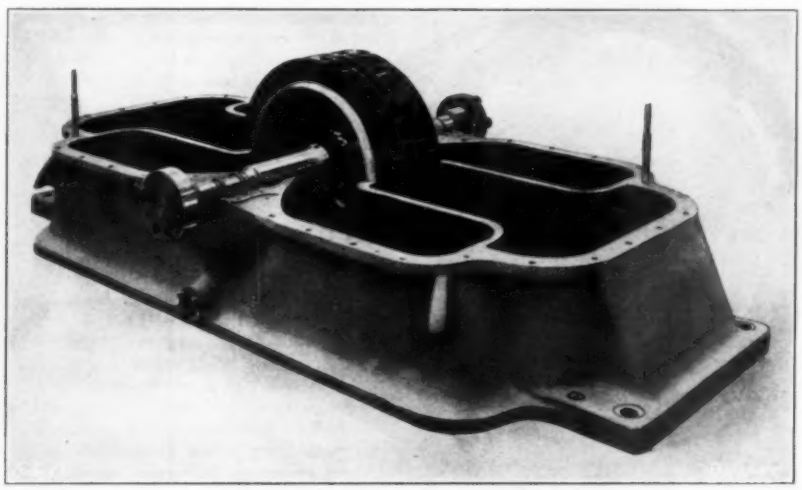


FIG. 21—ROTOR OF BLOWER IN LOWER HALF OF CASING

The exciter for the alternator is illustrated in Fig. 22 on the opposite page. It is a self-contained machine, with its own bearings and is flexibly coupled to the end of the blower shaft. It generates 370 ampères at 230 volts, having an electrical output therefore of 85·1 kilowatts. The field is of the six-pole type, with interpoles. The armature is provided with transverse holes through the laminations and end plates, so arranged as to cool not only the armature itself, but also to blow air through the commutator connections. Heavy steel insulated rings, shrunk over the ends of the commutator bars, hold the latter against the centrifugal force due to the high speed of rotation. The bearings are of the ordinary ring-oiled type, and serve also to locate the shaft axially by means of shoulders on the latter.

TESTS OF MACHINE BY PROFESSOR DRESDEN.

An independent test of the unit was carried out in Schiehaven power station on August 27th last by Professor D. Dresden, of The Hague, the results of which are tabulated below. For the sake of completeness, we give first in Table I. certain particulars of the turbine in British units, which will enable its performance to be better appraised. The machine, it will be remembered, was designed for an economical load of 16,000 kW, and a maximum continuous load of 20,000 kW, the speed being 3000 revolutions per minute. The designed stop valve pressure was 170 lb. per inch (gauge), the steam having a total temperature of 662 deg. Fah.

The blade clearances given must, of course, be considered in the light of the whole design, as the individual rotors are short and rigid, and the two

flexibly coupled turbine shafts have each an adequate double thrust block.

The steam arrived at the turbine by two pipes, as has already been mentioned, both pipes coming from a common receiver in the boiler-house fed by several boilers. As the individual boilers delivered steam at different temperatures, there was a possibility of the superheat being different on the two sides of the turbine when both stop valves were in use. The mean temperature of the whole of the steam used by the turbine was therefore deduced from measurements of temperature and pressure in the two nozzle boxes, the quantity passing through each nozzle box being proportional to the pressure as the nozzles were similar in the two boxes. The vacuum in the exhaust branches was deduced from the readings of two thermometers inserted near the horizontal joints. One thermometer was placed in each branch and their readings were identical.

The turbine was designed to pass out steam for feed heating, and tests were carried out under these conditions, as well as with no steam being passed out. The condensate was measured by means of two calibrated water meters, of the Steinmuller tipping type. When the condensate was heated by the pass-out steam, the method of measurement gave rise to certain difficulties. In the first place, the meter tank being open, a certain amount of evaporation took place from the hot water being measured. Losses also took place during the emptying of the tank, as the water wetting the sides suddenly evaporated instead of flowing down to the bottom, as it would have done if cold. A correction for these losses was deduced from the temperature drop of the water. Another source of error was introduced by the fact that the hot water, having a greater specific volume than cold water, filled the tank to overflowing before tipping occurred. The quantity of water which overflowed was caught spearately and accounted for. The total correction for the errors mentioned was never over 1·2 per cent. of the water measured. In Dr. Dresden's opinion, there was probably an additional small loss, due to the upward air current over the hot tanks carrying away water from the inlet jet in fine droplets.

The values taken for the efficiency of the alternator under various conditions were derived from the calculated losses, and are believed by Dr. Dresden to be exact. It will be noted that the unit showed an efficiency ratio as high as 84·3 per cent., when developing 16,700 kW, this efficiency being computed from the condition of the steam at the stop valve, and, therefore, including all throttling losses. The figures at all loads are decidedly good, especially when the high vacuum during the tests is taken into account.

TABLE I.

	Impulse part.	H.P. reaction part.	I.P. reaction part.	L.P. reaction part.
Number of stages	2	10	12	2 × 5
Mean blade diameter in inches	38·4	32·0 to 33·2	37·0 to 41·5	61·4 to 62·0
Blade lengths in inches	1·16 to 1·61 and 1·34 to 1·61	2·83 to 4·1	4·0 to 8·4	2·48 to 14·4
Exit angle of blades, degrees	—	18 to 19	19 to 20	19, 19, 19, 22, 28 and 20, 22, 22, 26, 38
Axial clearance of blades, inches	0·118	0·21 to 0·25	0·25 to 0·283	0·26 to 0·32
Radial clearance of blades, inches	—	0·0236 to 0·04	0·03 to 0·05	0·2 to 0·4

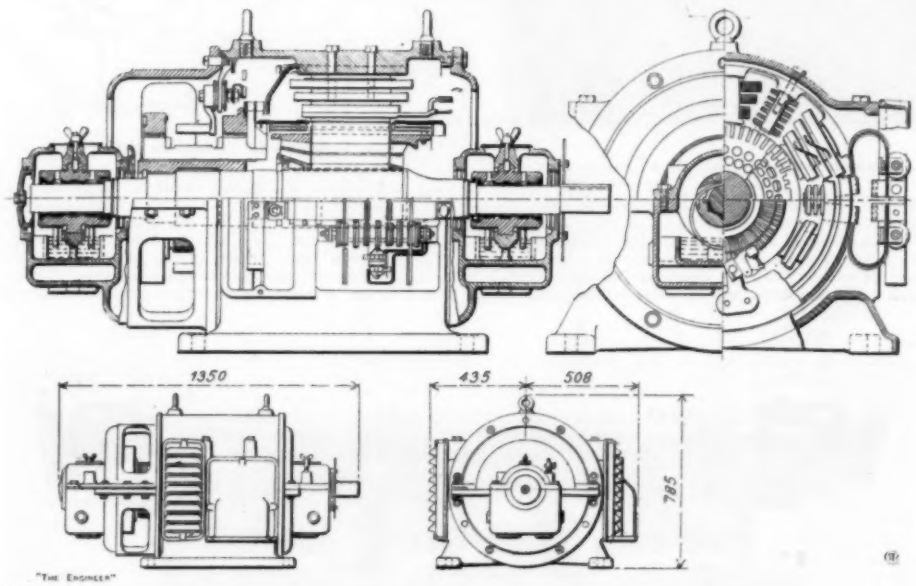


FIG. 22—DETAILS OF EXCITER FOR 20,000 kW ALTERNATOR

TABLE II.—*Tests of 20,000-kW Brown-Boveri Steam Turbine, Carried Out by Professor D. Dresden at Schichaven, August, 1927.*

Test number	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Time in seconds	2,033	1,530	1,305	2,320	1,950	1,691	2,609	1,661	2,319	2,524	1,192	2,362	2,099	1,694
Condensed steam, lb. per hour	169,000	166,500	173,000	123,000	122,000	130,500	87,000	86,000	89,500	201,500	202,000	166,000	210,000	167,000
(1) Gauge pressure at stop valve, lb. per sq. in.	179	179	180	173	176	170	182	181	171	176	176	173	179	178
Total temperature live steam, deg. Fah.	664	674	677	653	681	650	644	652	647	673	670	661	670	672
Gauge pressure at nozzle group I., lb. per sq. in.	174	173	179	159	163	159	119	120	122·5	175	176	170	179	178
Ditto at nozzle group II., lb. per sq. in.	158	156·5	171	98	96·5	109	—	—	—	176	176	156·5	178·5	160
(2) Absolute pressure in exhaust chamber in lb. per sq. in.	0·55	0·548	0·534	0·467	0·527	0·52	0·454	0·404	0·443	0·61	0·61	0·525	0·596	0·66
Adiabatic heat drop (1) to (2) in B.Th.U. per lb.	430	435	437	435	437	427	436	444	435	428	427	430	428	424
Load in kW	16,778	16,790	16,885	11,952	12,060	12,155	7,936	7,989	8,036	19,990	20,038	15,873	20,050	16,562
Cos ϕ	0·81	0·81	0·78	0·76	0·82	0·89	0·77	0·78	0·78	0·84	0·84	0·76	0·84	0·8
Alternator efficiency, per cent.	94·8	94·8	94·7	93·5	93·7	93·7	91·3	91·4	91·4	95·4	95·4	94·5	95·4	94·8
Steam consumption, lb. per kWh	10·1	9·94	10·2	10·3	10·15	10·73	10·93	10·78	11·15	10·1	10·1	10·48	10·48	10·12
Temperature condensate in extraction pump, deg. Fah.	82·4	82·4	80·6	77·9	82·4	81·7	77·9	74·3	77	84·7	84·7	—	86	—
Temperature condensate after heater, deg. Fah.	—	—	179·2	—	—	175·1	—	—	161·6	—	—	—	198·5	—
Efficiency ratio referred to heat drop (1) to (2), per cent.	83·0	83·6	—	81·3	82·3	—	78·3	78·4	—	83·2	83·3	—	—	84·3
Heat consumption in B.Th.U. per kWh	13,150	12,970	12,400	13,450	13,300	12,910	14,220	14,010	13,540	13,160	13,155	12,560	125,000	13,150
Thermal efficiency at the terminals without feed heating, per cent.	25·02	26·31	—	25·37	25·66	—	24·0	24·36	—	25·93	25·94	—	—	25·95
Ditto with feed heating, per cent.	—	—	27·35	—	—	26·43	—	—	25·20	—	—	27·17	27·19	—
Cooling water inlet, deg. Fah.	64·0	64·0	64·2	64·4	64·4	64·4	64·4	64·4	64·4	64·4	64·4	65·5	65·7	65·8
Cooling water outlet, deg. Fah.	76·1	76·1	75·2	73·2	77·2	77	73·9	70·7	73·4	78·6	78·6	—	78·8	83·7

SIXTY YEARS AGO.

THE practice of insuring oneself before going on a railway journey would seem to be almost a thing of the past in this country. Very rarely are we now asked by the booking clerk whether we wish to take an insurance ticket covering the journey. That the practice is dead or almost so may be ascribed to the recognition by the general public of the fact that on a British railway the chances of meeting with death or disablement are not greater, and, in fact, are probably less than they are in the execution of one's ordinary vocation. In former days our ancestors before going on long journeys took the precaution of making their wills. When railways brought a vast extension in the facilities for long-distance travelling, when a journey from London to Edinburgh ceased to be an event, the excitement of which remained with the traveller for the rest of his life, the habit of making one's will before setting forth on a distant visit fell into disuse. Sixty years ago, however, railway travelling was nothing like as safe as it has since become, and, particularly in the United States—where, to quote from our issue of May 15th, 1868, railway travelling had become "an excessively dangerous species of excitement"—the practice of insuring one's life for a railway journey had grown to be a common business necessity. In addition to developing this system of obtaining compensation for any mishap that might occur, steps were being taken to minimise the effects of an accident, should one take place. An invention with this object in view was briefly described in the issue we have referred to. It was the product of a Philadelphia man, and consisted of a railway car in the form of an iron cylinder, "strongly ribbed and girded to prevent crushing and thickly padded inside to save those within who, in case of an upsetting down an embankment, would be merely rolled over one another without loss of life." It is curious to note that while in America steps such as these were being taken, people in this country were agitating in favour of the adoption of lighter rolling stock than that then in common use. We referred to our own views on this subject in this paragraph a few weeks ago. In the issue quoted above, we find a note on it from the pen of James Nasmyth, the veteran inventor of the steam hammer. Nasmyth was entirely in favour of a reduction in the weight of engines and carriages relatively to the weight of passengers accommodated. He felt convinced, he said, that there was a vast disproportion between the passenger load and the weight of the engines and carriages used for its transportation, and that the "enormous excess" might be reduced to an extent which would secure a most acceptable economy in working and maintenance expenses without affecting the safety and comfort of the passengers.

A Geared Steam Rail Car.

DURING the past year over twenty Sentinel-Cammell steam rail cars of the chain-driven type have been in operation on various parts of the London and North-Eastern Railway Company's system. The results obtained have been such as to warrant the company ordering a further twenty similar cars, in which important improvements in the design of both the car body and the power unit have been embodied. The coachwork for the new cars was built at the Nottingham works of Cammell, Laird and Co., Ltd., and the engine and boiler, with the driving controls, were made by the Sentinel Waggon Works, Ltd., at Shrewsbury, the whole of the work being carried out to the requirements of Mr. H. N. Gresley.

In the following article we give an illustrated description of the first car of the new type to be delivered, which underwent demonstration trials between York and Harrogate on Friday last, May 11th. By the courtesy of the builders, we are also able to give some detailed particulars of a bench trial made on one of the new six-cylinder horizontal engines with which the cars are equipped, and some results of a trial run made on May 7th from York to Whitby, returning by Scarborough to York. The new design of car we illustrate represents, we are informed, the most recent Sentinel-Cammell practice now being applied to the rail cars which are being built for other home railways and for several railway undertakings overseas.

The New Design of Car.—In Fig. 1 we show a head view of the new rail car. It was taken on the trial above referred to near the Ravenscar Tunnel. The principal feature of the new body construction is the use of framework longitudinals, which run from end to end of the car. The car is carried on two standard bogies. The engine is of a new six-cylinder single-acting horizontal type, and is arranged transversely under the body. The power is transmitted through a universally jointed cardan shaft to a gear-box arranged on the front axle of the bogie.

A good idea of the general structural design will be obtained from Fig. 2, which shows the car body partly finished. The usual Sentinel-Cammell light steel construction has been retained, a feature being that both the sides and roof of the car form an integral part of the whole structure, and contribute to its strength. The two doors are of the sliding type working on "Crittall" runners,

one giving access to the main body of the car and the other to a luggage compartment, which is immediately behind the forward driving compartment. On each side of the car are eight curtained windows with small fanlights above them. Seating accommodation is provided for fifty-six passengers on reversible seats, designed by Cammell, Laird and Co., Ltd. Hand straps are fitted for the use of a further twenty passengers. The interior of the car is lined with mahogany and the roof is neatly finished with "Sundeala" panelling. Steam heating is provided, with efficient ventilation, and the electric lighting is carried out on Messrs. J. Stone and Co.'s 24-volt system, the dynamo being driven from the forward axle of the trailing bogie. The vacuum brakes are of the standard Gresham-Craven type. In Fig. 3 we show the trailing and the driving bogies. It may be noticed that the wheels are of the "Newlay" pattern with solid discs, the diameter on the tread being 37in. The general construction of the bogies follows approved lines, and the axle-boxes are furnished with laminated steel springs and rubber auxiliary springs which showed during the highest speed of the trials easy riding, in every way comparable, we are informed, with that of heavy main line stock. A light type of buffer and draw-gear—see Fig. 1—has been fitted to the cars so that light loads, such as a horse box, can be hauled when desired.

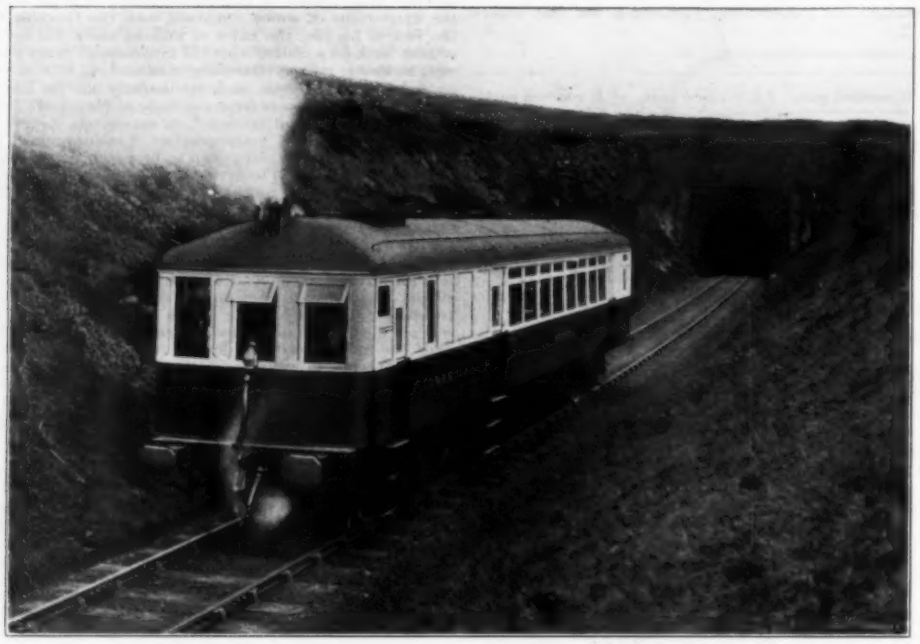


FIG. 1—THE NEW SENTINEL-CAMMELL GEARED STEAM RAIL CAR

FIG. 2—BODY CONSTRUCTION

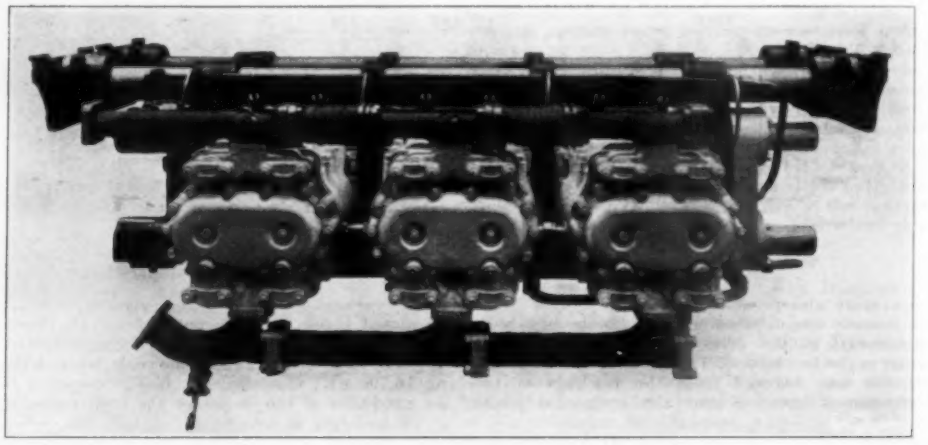


FIG. 4—FRONT VIEW OF SIX-CYLINDER HORIZONTAL ENGINE

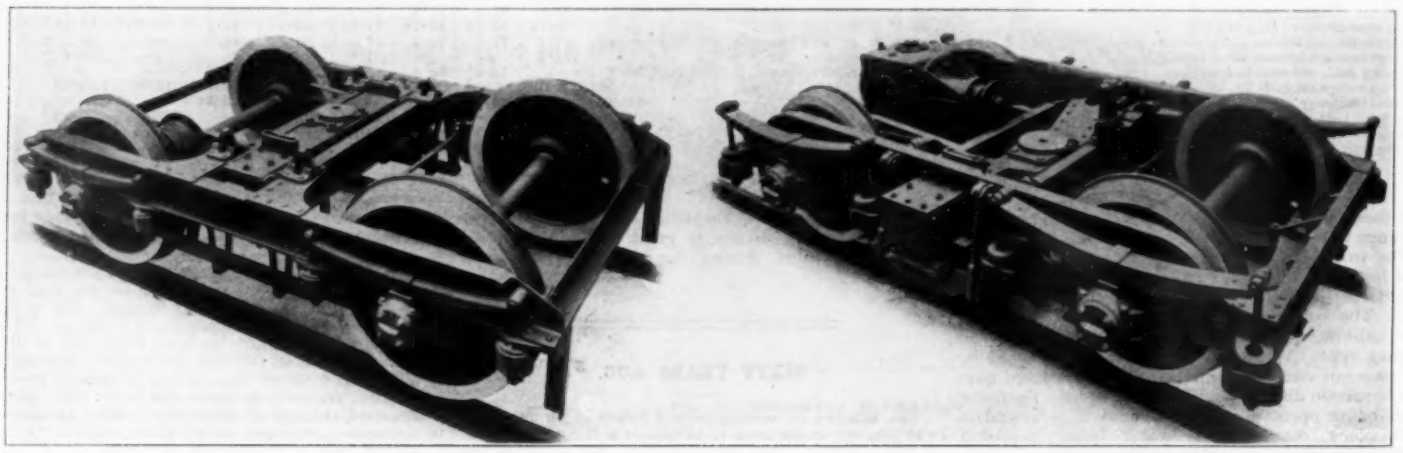


FIG. 3 TRAILING AND DRIVING BOGIES OF THE NEW RAIL CAR

The principal dimensions of the vehicle are as follows:—

Length over buffers	62ft. 8in.
Length over body	58ft. 6in.
Bogie centres	40ft. 7in.
Driving bogie wheel base	7ft.
Trailing bogie wheel base	6ft. 6in.
Diameter of wheels on tread	37in.
Overall width of car	9ft.
Height from rail to roof sheet	12ft. 4¼in.
Height from rail to buffer centre	3ft. 6in.
Centres of buffers	5ft. 8in.
Designed seating capacity	56 persons
Tare weight of driving bogie	18 tons 12 cwt.
Tare weight of trailer bogie	10 tons 3 cwt.
Weight of car in running order	31 tons 15 cwt.
Designed speed at 500 r.p.m.	38 miles per hour

The Gearing and Transmission System.—The gear-box and torque bracket will be seen in the engraving, Fig. 5, at the centre of the front axle of the driving bogie. The spur gear on the main axle has a face width of 6in., with forty-one teeth of ⅜in. diametral pitch. It meshes with a similar thirty-four toothed wheel on a splined lay shaft, carried in roller bearings, to which is attached a forty-seven toothed spiral bevel, which, in turn, meshes with a forty-six tooth bevel wheel on the cardan drive shaft. This shaft is well supported in roller bearings. The gears run in oil and a simple indicator rod is fitted along with a filling cap and strainer. Access to the gear-box is given by an inspection door on the forward face of the box. There is a torque stay bolted to the gear-box and the links are suspended one above the box. The motion is transmitted from the engine to the gear-box, as already said, through a universally jointed and splined cardan shaft, having a length of about 7ft. between the joint centres, with a diameter of 2in. Any relative motion between the bogie axle and the engine is entirely taken up by the

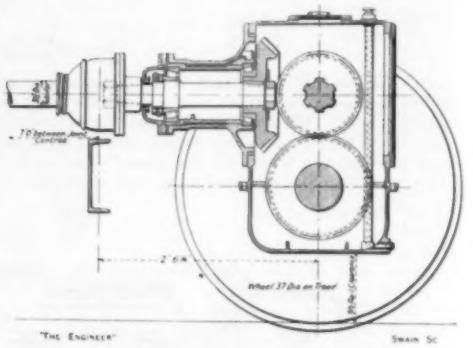


FIG. 5 SECTION THROUGH GEAR BOX

universal joints and splines, and no motion is transmitted to the engine itself.

The Engine and Boiler Units.—The power unit, a front view of which is reproduced in Fig. 4, has a designed output of about 130 B.H.P. at 500 r.p.m. The cylinders have a bore of 6in. with a stroke of 7in. Poppet type valves are employed, as shown in the engine sections, Fig. 6. In this particular design three running positions, corresponding to early, intermediate and late cut-off, are provided for in either direction of rotation, as well as a central position,

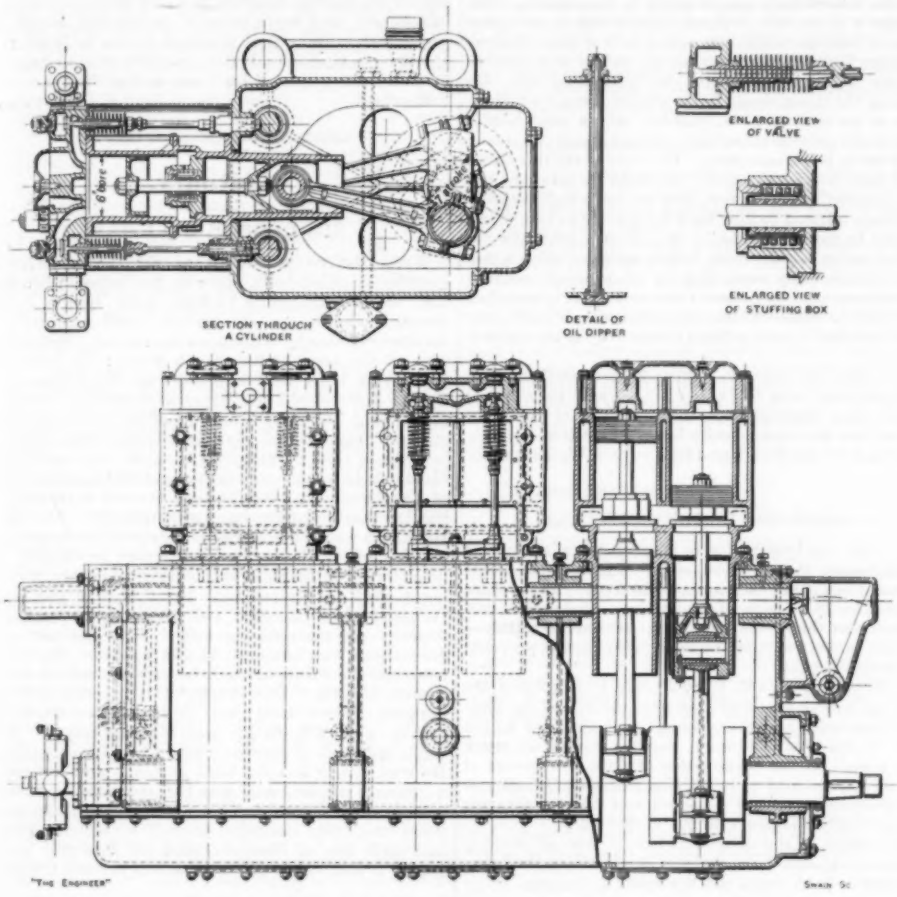


FIG. 6—PLAN AND SECTIONS AND DETAILS OF ENGINE

in which all valves are held open. The crank shaft is carried in four bearings, and can be inspected by removal of the side door; smaller circular doors are also provided which give access to each of the bottom ends. The cylinders, with the inlet and exhaust valve assemblies, are in clear view on one side of the coach, the engine being suspended beneath the coach well clear of the front bogie. On the underside are inspection doors, which are accessible from the ground or from a pit, while above the engine, in the luggage compartment, removable floor panels are provided, which allow the top side of the engine to be easily got at for examination. There are no flexible steam pipes or controls, both the engine and the boiler being firmly attached to the framework of the coach. The curve we reproduce—Fig. 9—shows the output of the engine on the bench trial at various speeds and with different cut-offs. The diagram is prepared for a pressure of 275 lb. per square inch, but the increase in power for 300 lb. pressure has been indicated by a dotted line, for one of the cut-off positions. Below the curve two typical indicator diagrams for intermediate and early cut-offs are given. During a two-hour trial with the engine running at 400 r.p.m., when supplied with steam at a boiler pressure of 275 lb. or 250 lb. at the throttle valve, and a total temperature of 659 deg. Fah., the engine developed 136 B.H.P., and the water consumption was 16 lb. per B.H.P. per hour.

At the same boiler pressure a further two-hour trial was run, with early cut-off. The steam pressure at the engine was 260 lb. and the steam temperature 604 deg. Under the conditions the power developed was 98 B.H.P., and the water consumption was 17·15 lb. per B.H.P. per hour. The maximum starting torque was shown to be 3420 foot-pounds at 300 lb. boiler pressure.

The boiler is shown in Fig. 7. It is of the "Super-Sentinel" vertical water-tube type, and is designed for a working pressure of 300 lb. per square inch. The heating surface is 14·73 square feet, with a grate area arranged for coal firing of 5·1 square feet. The superheater consists of a twin coil and is designed to give a total steam temperature of from 650 deg. to 700 deg. Fah. under various conditions of service. The usual complement of boiler accessories is provided, and an effort has been made to reduce radiation by the introduction of an air casing over the boiler top and round the base of the funnel. This precaution, in addition to the efficient lagging of all heated parts, has resulted, we learn, in a very cool driving compartment being obtained. The boiler is so arranged that the whole of the fire-box with the water tubes can be lowered out of the boiler for cleaning and repairs. Access to the apparatus for dropping the hinged pin and half fire-grate is gained from the front of the car. On the car we are describing a 2¼in. by 3¼in. by 5in. Weir vertical feed pump is provided. It will be seen to the left of the boiler. In future cars it is proposed to use twin ram pumps driven by the engine, which, we understand, will effect a certain saving in steam.

The coal bunkers, which are completely enclosed in the body of the cars, are designed to carry 30 cwt. of fuel, which is sufficient for about a 300-mile run. The coal is filled through flap doors in the roof. There is a single water tank with a filling arrangement for either side of the car. It is placed at the back of the cab and has a capacity of about 315 gallons of water, which is sufficient for a run of about 60 miles. In future cars the capacity of this tank will be increased.

The engravings, Figs. 7 and 8, show the driving controls in the forward and rear compartments. The control columns carry the steam admission and the reversing levers. In the forward control pillar there is mounted the throttle valve, which is operated by a single link from the throttle control lever. The design is such that the valve chest can be quickly removed for inspection. All other controls to the rear driving compartment consist of stout rods, which are guided and lubricated, and are pin-jointed at the ends. The roomy character of the driving compartments and the ample window space, which permits a clear view of the track to be obtained, may be remarked upon. A mechanical screen wiper operated by suction is fitted, and seats for the driver are arranged in both cabs.

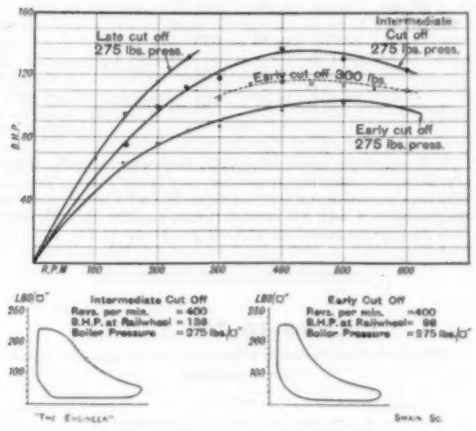
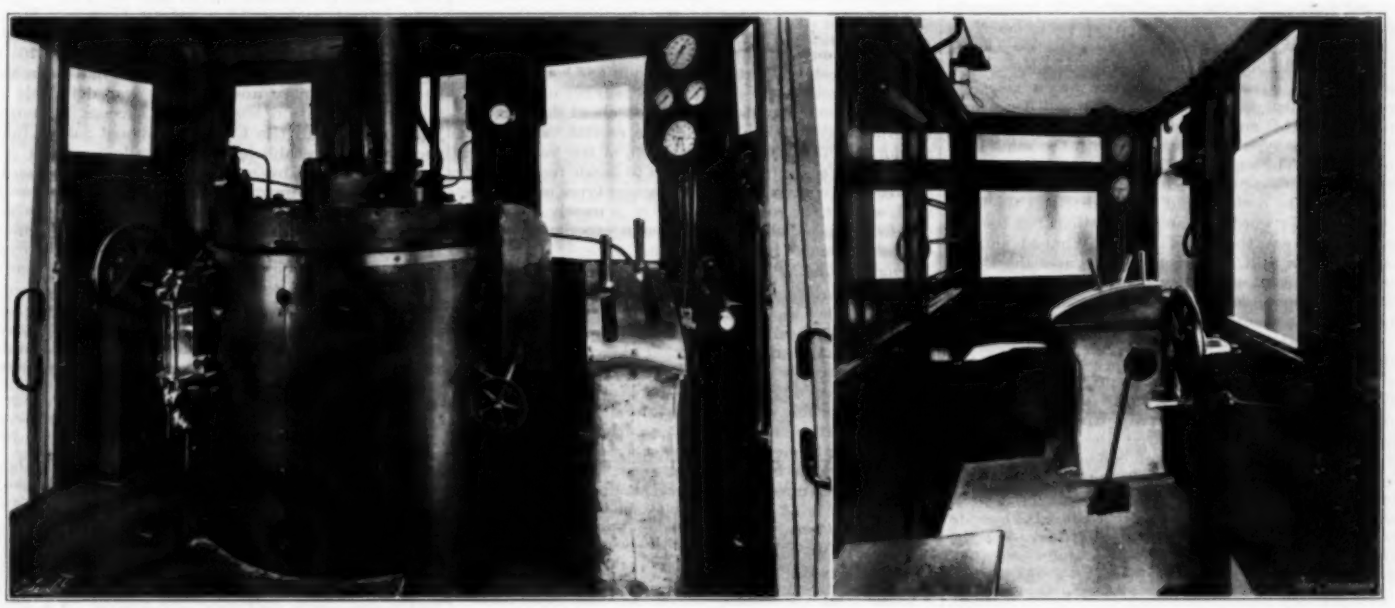

Late cut off 275 lbs. press.
Intermediate Cut off 275 lbs. press.
Early cut off 300 lbs.
Early cut off 275 lbs. press.
B.H.P.
R.P.M.
Intermediate Cut Off
Revs. per min. = 400
B.H.P. at Railwheel = 136
Boiler Pressure = 275 lbs./□"
Early Cut Off
Revs. per min. = 400
B.H.P. at Railwheel = 98
Boiler Pressure = 275 lbs./□"
"THE ENGINEER"

FIG. 9—SPEED-OUTPUT CURVES WITH CARDS

Some Road Tests.—In conclusion, we may refer to some of the results obtained in recent maker's trials, which were run between York and Whitby and Scarborough and York on May 7th. The weight of the car in running order is 31 tons 15 cwt., but for trial purposes the weight was increased to 33 tons, to allow for, say, sixteen passengers, with luggage, &c. The car left York at 10.20 a.m. and arrived at Whitby at 12.19 p.m., after a good run. The general absence of engine vibration and the quiet running of the gears were subjects of comment. During part of the run acceleration tests were made on gradients and on the level with varying boiler pressures and cut-offs. Robin Hood's Bay was left at 1.58 p.m., and York was reached at 4.37 p.m. The maximum speed timed during this run was 55½ miles per hour, corresponding to an engine speed of 750 r.p.m. Even at this speed there was, we learn, no undue swaying or lurching.

An interesting part of the run was the climb up Ravenscar gradient, which for the most part is 1 in 39. We



FIGS. 7 AND 8—FORWARD AND REAR DRIVING COMPARTMENTS SHOWING CONTROLS

extract from the trial figures some details of this run, and give them in tabular form:—

Trial on Ravenscar Gradient at Intermediate Cut-off.

Time.	Seconds for ¼ mile.	Miles per hour.	Average gradient	Boiler pressure lb./sq. in.	Remarks.
0					Throttle not wide open:
	42	21·4	1 in 103	275	Curves bad
42					
	53	17·0	1 in 82	295	Curves bad
1·35					
	61	14·75	1 in 39	295	Throttle wide open:
2·36					
	70	12·85	1 in 39	280	Bad curves
3·46					
	70	12·85	1 in 39	280	Bad curves
4·56					
	64	14·05	1 in 39	290	
6·00					
	61	14·75	1 in 39	285	Curves
7·01					
	62	14·5	1 in 39	285	
8·03					
	58	15·5	1 in 39	295	
†9·01					
	58	15·5	1 in 39	295	Curves
9·59					
	62	14·5	1 in 39	290	Tunnel
11·01					
	60	15	1 in 39	295	Throttle closed at 11 min. 50 sec.
12·01					

The readings were taken at the quarter-mile posts, starting from the first post out of Flying Hall. The car had accelerated from zero to about 20 miles per hour on an up gradient of 1 in 103 at that point, and the throttle lever was in the intermediate cut-off position.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

LOCOMOTIVE DEVELOPMENT.

SIR,—If everything that is new is interesting, the account given of the "Kitson-Still" locomotive in THE ENGINEER for May 4th should be of interest. Unfortunately there is a tendency to pay too much attention in this country to unimportant departures from established types. One has only to consider the development of the motor car and motor bicycle industry in this country with the corresponding development in the United States. The ratio of the number of types to the total number of units produced is enormous compared to the corresponding ratio in America. The accepted opinion in America seems to be that to procure first-class development and progress in industry and science there must be few steps, and each step an important advance on the preceding one. Fortunately for this country the great minds who have been responsible for the development of the British Navy have been very much alive to this idea. Outside of the Admiralty, with the exception of the Rolls-Royce Company, Ltd., we seem to look in vain in this country for a proper recognition of this principle, and, least of all, in our railway systems.

In a hundred years of development the number of types and fancies and fads is both deplorable and disgusting, and the Press unfortunately contributes to the general coma, and deals out large packets of opium. As an example when one of the large "Pacific" type express locomotives was on show at Wembley some time since, the newspapers were bursting with information concerning the latest type locomotive. As a matter of fact, the writer travelled more than twenty years before that in the "Twentieth Century Limited," on the New York Central Railroad, behind the same type of locomotive, with the same type of valve gear. The suggestion has been put forward that because the "Kitson-Still" locomotive failed on the route selected for it, the route should be found to suit the locomotive. In other words, because the patient has become more sodden increase the dose of opium. What advantages can the "Kitson-Still" locomotive claim over the Diesel electric locomotives, which have been running for some years on the Canadian National Railway?

This type of locomotive can produce full load torque in any condition and at any speed, from nothing to maximum, which no locomotive of the "Kitson-Still" type can possibly do. The engine referred to on C.N.R. has been developed by Messrs. Beardmore and Co., and, according to the Press, it is going to be given a trial in Lancashire. It might be possible to make three sizes, say, 750 H.P., 1500 H.P., and 2250 H.P., each of one or more 750 H.P. units, and by using the "Austin" method of electrical transmission, on account of its "fool proof" features, arrange them so that two men only were required to operate them when three units were coupled together. For the benefit of those who hold the absurd and unscientific opinion that an electric motor is not a mechanical machine, it might be pointed out that the more we know about electrons, the more we realise that there are no mechanical machines in the old-fashioned sense, but that all machines are tied together, as it were, by elastic bands.

For the benefit of those who still put their faith in steam engines, it may be still pointed out that there are certain possible developments that appear to have been overlooked. If it is possible to use a geared drive with an electric locomotive and also with a motor car, and travel at a very high speed, it might be an advantage to use a geared drive for a steam locomotive. By this means the cylinder could be made single acting, and therefore of a uniflow type. A double-acting uniflow type engine does not seem suitable for high speeds, and it is possible that a high-speed single-acting uniflow engine could be made which would gain in the ratio of power to space and weight compared to the double-acting type. The "Michell" crankless engine is a type that might be suitable for this development, and by placing three or four "Michell" crankless single-acting steam engines between the driving wheels and geared to them, triple or quadruple expansion results might be obtained. On account of the proximity of the boiler to the engines reheating of the exhaust steam from the intermediate stages might be practicable. The economy of steam thus obtained might enable much higher pressures possible, 600 lb. per square inch or over, without increasing the weight of the boiler, and so still further economy would be obtained. An interesting idea for reheating the steam would be to provide a small auxiliary boiler in its crudest form, possibly only a steel bottle, which would provide extra high-pressure steam; anything over 1500 lb. per square inch. The steam from this boiler would have a closed circuit. It would be taken to the parts required by small pipes, and the extra high pressure condensate allowed to flow back by gravity to the boiler. It might be worth considering to provide a preheater for the feed-water for the main boiler, arranged with a flap valve automatically controlled by temperature, so that the hot gases were by-passed if the feed water approached too nearly to steam-raising temperature. Finally, any steam locomotive fired by hand is unworthy of the name of modern.

Now that the railway companies are amalgamated, there does not seem to be any reason why they should not provide a research department capable of producing a locomotive that could really be called modern.

Saltburn-by-the-Sea, May 14th. W. ROGERS.

COSTS FOR MANUFACTURERS.

SIR,—In your book review of May 4th there is conveyed the impression that the cost of the foreman who directs the operations of the machine is decided solely on the space occupied by this factor of production. Under this misapprehension the review goes on to say—quite rightly—that the hours the machine is at work would probably be a safer criterion.

In fairness to myself, I should like to emphasise the fact that in both text and examples, the cost of the foreman, otherwise "superintendence," is determined by the hours the machine is at work, plus the cost of the space it occupies. By the combination of these two factors of time and space into a unit "rate per hour," I suggest the criterion of exactness is reached, and that the reviewer does not really disagree with me on this point.

The essence of the system, in fact, is that all working expenses, both direct and indirect, are based on the hours the machine is at work, and the space it occupies.

Your claim that leading concerns in the engineering industry have up-to-date costing systems may be admitted without question, but even so, the simple method of arriving at and applying this "unit rate of expense," based on time and space, may perhaps be incorporated into such systems with distinct advantage. Whatever internal difficulties may present themselves can usually be overcome. At least we shall agree that any measure that tends to exactitude in recovering overhead charges, will help the British engineering industry against external competitive prices.

Regarding the surmise, that in the case of overtime, the cost may be equated by the compensation between "increased productive hours" (increased wages) and decreased "oncost," I do suggest that my "revision unit rates" unquestionably decides this point and leaves nothing to chance.

With reference to the point raised about depreciation, I have allowed 10 per cent. of the capital value of the machine on the assumption of a life of ten years. It is the province of the technical expert to decide the difference between the effective life of the various types of machines used, and for the cost accountant it is merely a question of interpreting that expert opinion or experience into the equitable amount for depreciation.

London, S.E 12, May 12th. CHARLES SMITH.

[We venture to suggest that our correspondent has not read the review as carefully as he might, or he would not have used the word "solely" in his first paragraph. The main point of our criticism was that while floor space might be a fair basis for allocating certain charges, for others it would be equally *unfair*. If we visualise a long boring machine absorbing a large part of the shop, and beside it a precision vertical milling machine, can anyone justify charging the former with more for "superintendence"? A system which has for its essence "that all working expenses, both direct and indirect, are based on the hours the machine is at work, and the space it occupies," is unsound. *Different bases* must be used for varying items of cost.—ED. THE E.]

THE USE OF WIRE ROPE IN STRUCTURAL FRAMEWORK.

SIR,—I was very interested in Mr. North's reply to my letter of April 24th. To make my use of the word "distortion" quite clear to Mr. North, I should have put the word "permanent" before it—although in view of the general tenor of my remarks, I think I was not unreasonable in assuming that the ordinary reader would appreciate that I meant permanent distortion.

Mr. North quotes experimental results obtained on 8ft. specimens of "straining cord of a particular lay," having an effective value of Young's modulus of 10,000 tons per square inch. He gives diagrams of 120 cwt. and 135 cwt. cables.

I am sure Mr. North would admit that I made it perfectly clear in my letter that I was not talking of short lengths of small cable. I was talking of cables such as will be used in R 101, which, according to Lieut.-Colonel Richmond's paper, have an effective E value round about 2500 tons to 3500 tons per square inch—if my calculations are not at fault.

Will Mr. North please advise me of any existing pin-jointed engineering structure in which long wires are used successfully, such wires being of no less size, length and strength than those it is proposed to use in R 101? If he will be so kind as to do this, I shall be glad to deal with the other paragraphs of his letter of May 7th.

May 14th. HEXAGON.

Obituary.

SIR GEORGE BUCKHAM.

WITH the recent death of Sir George Thomas Buckham, which took place at his home in Sheffield last week, Armstrong-Vickers Ltd. lose a valued director who was a recognised world authority on matters relating to ordnance engineering. Sir George, who at the time of his death was in his sixty-fifth year, was born and educated at Newcastle-upon-Tyne. He entered the Elswick Works of Sir W. G. Armstrong, Whitworth and Co., Ltd., as an ordnance engineer and served that firm until 1895, when he joined the staff of Vickers Ltd. After some time at Sheffield, he spent several years at the London offices of the firm. In 1901 he was elected a member of the Institution of Mechanical Engineers. Sir George Buckham was the designer of many of the larger guns which came into service as the war proceeded, and he also played an important part in the early development work associated with the design of the tanks. It was for the notable aid which he gave to the country on matters connected with gunnery that Sir George was knighted in 1917. After the war he returned to Sheffield and became attached to the company's River Don Works. As the chief ordnance designer to the firm, most of the recent work connected with the design and manufacture of Army tanks and their armament came under his supervision. He was widely known, both at home and abroad, as a gunnery expert, and was the recipient of honours bestowed by several foreign Governments. In recent years he closely identified himself with the industrial and civic life of Sheffield, and his loss will be felt among a wide circle of business and private friends.

CLEMENT BAYARD.

LAST week Monsieur Clement Bayard, the well-known French engineer and financier, died suddenly at the age of seventy-five. He was the son of a provincial locksmith, and after learning his father's trade went to Paris where he set himself up in a small shop and undertook the repair of the high-wheeled "velocipedes" then in use. He soon saw the possibilities of a low-wheeled bicycle, and was one of the first—some even claim him to have been the very first—to invent and build a safety bicycle. He had difficulty in persuading French financiers to invest money in a business for the manufacture of his new type of machine, but after the idea had been taken up in this country and when it was definitely seen that the invention would be a success, a company was formed and the Clement Bayard safety bicycle factory was established at Levallois. Soon afterwards he turned his attention to the motor car, then in its early infancy, and in a short time was producing the well-known Clement Bayard vehicles. Later, he played an active part in the development of the aeroplane and the airship. His airship experiments failed to realise full success, and less than full success also attended his aeroplanes, although we can recall the Clement Bayard armoured aeroplane at the Aeronautical Exhibition at Olympia in 1913, standing out in our estimation as about the only example in the hall which made any appeal to an engineer as possessing a sound structure.

THE Provincial Government of Quebec has authorised the Beauharnois Light, Heat and Power Company to proceed with its project for the development of power on the St. Lawrence. An agreement has been entered into between the company and the Government, under which the company may divert 40,000 cubic feet of water per second, between Lake St. Francis and Lake St. Louis on the St. Lawrence, and undertakes to develop 100,000 H.P. within five years, increasing the volume to a total of 500,000 H.P. within ten years. The company is to pay a yearly rental of 20,000 dollars for the first five years and 50,000 dollars per year after that date. A clause in the agreement forbids the exportation of any part of the output to the United States, but the company is permitted to sell to Ontario any surplus that it cannot dispose of in Quebec. In view, however, of the increasing demands of the industries in the neighbourhhod of Montreal, the company regards a home demand as assured. The carrying out of the enterprise will involve an estimated expenditure of 30,000,000 dollars, and the company is required to make a deposit of 500,000 dollars as a guarantee that it will carry out its undertakings.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Market Situation.

ALTHOUGH the market tone in the Midlands is brighter and prospects of increasing business seem more hopeful, buying and selling of iron and steel still lack weight. There has been a somewhat brisker inquiry for several classes of material this week, but orders are slow in materialising. Cautious buying is persisted in, and restricted activity at the mills results. In the Black Country plant is working at something like 60 per cent. of capacity only, whereas more than 90 per cent. is necessary for efficient production. To secure this implies that a considerable proportion of the orders at present going to the Continent should be diverted to British plant. The present relatively high price of foreign steel is helping local iron and steelmasters to secure some of the business which usually, on account of price, goes abroad, but a larger proportion of it is required to make any appreciable difference to the output of the furnaces and mills. The weekly iron market at Birmingham to-day—Thursday—was poorly attended, and the volume of business was again of a restricted and disappointing character.

Raw Iron.

The week has brought no change to the pig iron department either in the volume of demand or in relation to prices. Consumers of raw iron continue to press the advantage which rising stocks at the furnaces give them, but blast-furnacemen decline to accept business at unremunerative rates. It is contended that they would be willing to consider lower selling rates if they were assured of such an increase in the volume of business as would make it a profitable move. Recent price concessions, however, have failed to stimulate demand to the extent required, and Midland smelters can see no prospect at the moment of a different result, should they again test the market with reduced prices. The requirements of the local foundries show no material increase, and although some slight improvement at the forges is noted, it has not so far had any effect upon the raw iron market. With consuming industries in such a condition there is little hope of a real increase in demand, as a result of lower values. Accordingly most of the smelters stick to their quotations, disregarding cases in which lower rates are accepted. Northamptonshire foundry No. 3 is quoted £2 18s. to £2 19s., and Derbyshire £3 3s. 6d. to £3 4s. Northamptonshire forge is maintained at £2 13s. 6d., and Derbyshire £2 18s.

Finished Iron.

Staffordshire makers of best bars are reasonably busy, but there is little demand for second quality and common brands. Special engineering requirements furnish orders for the marked bar mills, and the basis price of £12 is maintained without difficulty. Keen competition for the small orders offering for Crown bars has led to prices being cut as low as £9 2s. 6d. Most of the makers, however, still quote up to £10. Nut and bolt bars at £8 17s. 6d. fail to find purchasers, Belgian No. 3 iron at £6 3s. 6d. being utilised instead. There seems little prospect of Staffordshire iron masters securing much of this business, nut and bolt makers stating that even after utilising the cheaper foreign raw material they have difficulty in successfully competing for orders for the finished goods. Many of the local tube makers are working under pressure. Orders are plentiful, and tube strip is in keen demand. Wrought iron tube strip sells freely at £11. This is the brightest section of the Staffordshire iron trade at the moment.

Steel.

There is a slightly improved tone in the steel department in this area. Output is steadily increasing, although tonnages remain small. Buying is, to some extent, interfered with by the expectation of a further adjustment of structural steel prices by the Association. Up to the time of writing, however, values were unchanged. The number of specifications received this week is larger than for some weeks past. Export trade has expanded very much during the past fortnight, and good inquiries have come through Birmingham merchants, covering nearly every description of steel. Demand from home consumers is also better. The disposition to buy British material in preference to continental since the increase of prices of the latter is encouraging to local producers. It is reported this week that constructional engineers in this area are recovering their activity. Inquiries are quite numerous. Railway orders placed with Midland rolling stock firms will enable the works to run on full time for some months to come, and considerable tonnages of steel will be consumed. Heavy quantities of constructional steel have been ordered for bridge and factory extensions. Boiler-plates are in request, many of the district boiler makers being well placed for business. There is an amended demand for tool steel, and semi-finished material. The prices of the latter remain as last week. Continental semis are again stiffer this week. Finished material participates in the stronger movements of prices, but in a less degree. There is little inquiry for imported iron and steel in this district. Supplies are coming in regularly, but consumers are content to await developments before making up their minds about new business.

Galvanised Sheets.

There has been a little brighter business in the galvanised sheet department this week. Overseas buyers have been sounding the market with regard to renewed shipments. Though the total volume of business remains disappointing, more orders have been booked during the past week than for some time past. Transactions have been negotiated on the basis of £13 f.o.b. for 24-gauge corrugateds. Though producers displayed anxiety to strengthen depleted order books, there was a significant unanimity of insistence upon the £13 minimum. There is a fair inquiry for tin-plates, but the amount of business done this week was not large. Wasters are in better demand for use in Birmingham and Midland factories.

Scrap.

Heavy steel scrap now realises £3 6s., but the sellers have not found it possible to obtain their full quotation of £3 7s. 6d. There is a good demand for cast iron scrap and machinery scrap. Heavy machinery scrap has made as much as £3 7s. 6d. per ton delivered, and light cast iron scrap £2 13s. per ton. The scrap market has been strengthened by the purchase of substantial lots running into thousands of tons, sold to Germany, Poland and other steelmaking centres. South Wales continues to take fair quantities owing to the improved demand for billets and bars for tin-plate production.

Production Returns.

Midlands industrialists were disappointed with the return of iron and steel production for the month of April. They had not anticipated any marked advance on the previous month's figures, especially considering the holiday break, but they were hardly prepared to find them lower than April last year. Under existing circumstances they consider it satisfactory that the number of furnaces in blast at the end of April was 149, a net decrease of only one; they note that three furnaces were recommissioned and four ceased operations. Production of pig iron in April amounted to 555,000 tons, compared with 592,600 tons in March, and 680,000 tons in April, 1927. The production included 186,200 tons of hematite, 184,000 tons of basic, 142,700 tons of foundry, and 22,600 tons of forge pig iron. Output of steel ingots and castings, amounting to 644,100 tons, compared with 793,300 tons in March, and 850,100 tons in April, 1927.

Coventry Engineering.

An improvement in business is reported by the majority of the Coventry motor engineering firms. There has been an acceleration in the demand for all types of light cars, and the sun-saloon models and the saloons with sliding roofs are called for by an increasing number of people who require a car for all purposes. The local firms engaged in the production of commercial vehicles have enjoyed quite a good run this year on the passenger-carrying side of the business, very substantial orders having come through, both for motor-coaches and omnibuses. There is a considerable volume of business on hand in both branches. The machine tool trade in Coventry remains busy, though orders are not coming through so freely as of late.

Cannock Chase Coalfield.

Coalowners in the Cannock Chase area in common with others who are leagued in the Five Counties scheme, are not making much headway with the attempt to increase selling prices. The principal effect, so far as one can judge, appears to be to throw a larger share of the trade into the hands of the collieries which have remained outside the combine. The small requirements of the market are met without sign of undue strain. Many associated collieries produced their stipulated quota earlier in the month, and have not much underground employment to offer now. Efforts to obtain advanced prices are still being made, there being no formal withdrawal of the rises of 1s. to 1s. 6d. announced by the collieries. The proportion of output which is being sold at the enhanced rates is, according to all the indications, insufficient to sway the market.

Miners Receive Notice.

Trade depression persists in the Cannock Chase coalfield, and it became known this week that 200 men employed at the pits of the Cannock Chase Colliery Company, Chasetown, are to receive notices to cease work. It is pointed out that it is not solely due to the smallness of demand that so many fewer hands are required at the pits. Lately the Cannock Chase Company has carried out an important scheme of concentration of its plant, and has installed a considerable amount of coal getting machinery, all of which tends to reduce the amount of man power required in the pits and on the surface.

Unemployment.

Following a large increase in the previous return showing the number unemployed in the Midlands, the current figure records a decrease of 8386, the total being down to 146,480. Birmingham has lost ground on the week, the figures having increased from 24,040 to 25,387. In the Coventry area there has been a slight decrease in the number of workless, pointing to increased activity in the motor-engineering shops. Most of the Black Country towns record higher figures, Walsall and Wednesbury being exceptions.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Overseas Trade in Textile Machinery.

SHIPMENTS of British textile machinery during April, although below the monthly average for this year, owing in a large measure to the incidence of the Easter holidays, show a marked improvement over the corresponding period in either of the two previous years. The quantity exported was 9635 tons, of a total value of £901,193, compared with 8475 tons and £838,141 in April, 1927, and 8833 tons and £835,997 in 1926. Of last month's exports 6836 tons and £665,270 represented spinning and twisting machinery and 2411 tons and £167,810 weaving machinery. British India was the most important individual market for British textile machinery during April, taking shipments to the value of £198,432, followed by Japan with £94,757, exports to the latter market being double those in April of either of the two preceding years. Russia, also, continues to show a marked improvement, shipments thence being valued at £93,014. Exports to the Netherlands were £62,538, to Germany £60,367, South America £50,883, France £44,105, the United States £34,106, Australia £15,897, China £7557, and "other European countries" in the aggregate £208,176.

A Depressed Home Market.

Reference to continued depression in the home market for textile machinery was made by Sir George Bullough, at the annual meeting of Howard and Bullough, Ltd., textile machinists, of Accrington. It was explained that the past year had been one of very keen competition, arising from a restricted demand when compared with the large output capacity of the textile machinery makers. With rare exceptions the home trade had continued in a very depressed condition and most of the company's output had been for export. The shareholders were receiving a dividend for the half-year ending March 31st last at the rate of 6 per cent. per annum, less tax, on the preference shares, and a fourth quarterly dividend of 2½ per cent. on the ordinary shares, making 10 per cent. for the year. Varying degrees of improvement are shown in the annual reports of two other Lancashire firms engaged in the same branch of engineering. Brooks and Doxey (1920), Ltd., of West Gorton, Manchester, disclose a trading profit of £4041. After allowing £22,000 for depreciation, however, there is a net loss of £17,989, which, including the debit balance brought forward, makes a total of £140,577 to be carried forward to the debit of profit and loss account. In the previous year, however, there was a trading loss of £13,457, before any allowance was made for depreciation. Tweedales and Smalley, Ltd., of Rochdale, report a net profit for 1927–8 of £77,330, compared with £74,389 and £69,259 in the two previous years, a distribution of 15 per cent. again being made.

A Scheme Abandoned.

The Altrincham Urban District Council has now decided not to proceed further with the proposed scheme for the purchase of the Altrincham electricity supply undertaking. Recently the Council decided, by a bare majority, to apply to the Electricity Commissioners for power to set up a joint board of control composed of representatives of the urban authorities of Altrincham, Ashton-on-Mersey, Bowdon and Hale, and the Rural Council of Bucklow.

Not to be Closed Down.

Rumours have been current during the past few days to the effect that the Horwich locomotive works of the London, Midland and Scottish Railway Company were to be closed down in the near future owing to the transfer of the works to Crewe and Derby. These rumours have now been authoritatively denied. It is believed that they arose because a number of men in a certain department of the works were stopped owing to slackness.

The Late Mr. W. H. Davies.

The death has occurred in Manchester of Mr. W. H. Davies, formerly chief instructor in the mechanical engineering workshops of the Manchester College of Technology, at the age of seventy-three. Mr. Davies retired about five years ago after thirty-eight years' service on the staff of the College.

Non-ferrous Metals.

Steady to firm conditions have been in evidence in all sections of the non-ferrous metals market during the past week, both copper and tin, more particularly the former, registering advances, and lead and spelter keeping steady. In the copper section buying interest has not been very pronounced, but the fact that offers of the metal have not been too plentiful has served to force up prices of standard brands by about £1 a ton compared with those current a week ago. Present indications are that supplies will continue to be readily absorbed for the time being. An improvement at the consuming end of the tin trade, combined with another drop in stocks of the metal in this country, has had a bullish influence on prices, although nothing of a spectacular nature in this respect has occurred, the advance being only on a relatively modest scale. Conditions in the case of lead, from the point of view of consumption, seem to show a slight improvement, and values have kept up at the level of the two previous weeks. There has been a moderate amount of interest shown in spelter and prices in this section, although unchanged on balance, compared with a week ago, have shown a continued steady tone.

Iron.

Pig iron interests on the Lancashire market have experienced anything but cheerful conditions during the past week. The demand shows no sign of broadening and there is a continued lack of interest among consumers in connection with covering future needs. On the whole, deliveries against contracts that are unexpired are moderately satisfactory, but, partly because of unfavourable trade conditions at the foundries and partly, no doubt, because even at to-day's prices there seems to be some doubt as to their stability, buyers generally are extremely reluctant to venture far ahead. The result is that forward bookings have been on a very small scale and, as has been the case for several weeks now, current business is almost wholly a question of covering requirements during the next few weeks. It is not surprising, therefore, that the tone is anything but strong. For delivery Manchester or equal, Derbyshire and Staffordshire No. 3 are quoted at 71s. to 71s. 6d. per ton, North-East Coast brands at about 79s., Scottish at 87s. 6d., and hematite at 83s. to 83s. 6d. Buying interest in bar iron has been at about its usual moderate level, with Lancashire Crown quality quoted at £10 and seconds material at £9 10s. per ton.

Steel.

In the steel market here a certain amount of interest was aroused by rumours in the early days of the

week as to impending increases in the prices of British steel products to non-rebate buyers, and it was reported in some quarters that in anticipation of higher prices more interest had been shown in forward buying. Generally speaking, however, the demand, particularly from the constructional branch of the consuming trades, is on a quiet scale and for early deliveries. Prices are steady at £8 12s. 6d. for frame and general plates, £9 15s. to £10 for locomotive boiler plates, £7 17s. 6d. for joists and sections, and £8 17s. 6d. for steel bars, 3in. and upwards. Re-rolled bars are somewhat steadier in sympathy with dearer raw materials, and quotations range from £7 10s. to £7 12s., with £7 15s. being quoted in odd cases. Imported finished and semi-finished steel products continue to advance, Siemens plates being now at £8 to £8 2s. 6d. per ton, Thomas plates at about £7 10s., wire rods at £6 12s. 6d., angles at £6 12s. 6d., joists at £6 to £6 2s. 6d., billets at £5 10s., and sheet bars at £5 12s. 6d. per ton for cash against shipping documents and including delivery to Lancashire works.

BARROW-IN-FURNESS.

Hematite.

The condition of the hematite pig iron market is practically unchanged. In some quarters there is a slightly better feeling consequent upon a few more inquiries coming in. Business continues to be practically confined to immediate requirements, and there is still a holding off in the placing of orders for forward delivery. Stocks show a tendency to increase in some places, but that is due to the present idleness in the steel departments. Business with the Continent is not considerable and American trade is dull. The condition of the iron ore trade remains about the same and most of the business is confined to the district, but there are certain deliveries of better qualities to Scottish and other buyers. The steel departments are not doing much with the exception of the hoop mills, which are well employed. The rail mills at Barrow will not restart until after Whitsuntide, and this stoppage will enable the company to give its plant a thorough overhaul, which no doubt it will require after its long run, which has extended over two years.

Shipbuilding.

The vessels of the extensive fleet of the Isle of Man Steam Packet Company, which have been lying up at Barrow, are now completing their overhaul and several will leave for their stations this week-end. This company has now a fleet of fifteen steamers since the addition of the last two purchased from the L.M.S., namely, the "Antrim" and the "Duke of Connaught." Both of these vessels are to be re-named.

SHEFFIELD.

(From our own Correspondent.)

Steel Orders Scarce.

THE main branches of the local iron and steel trades continue to experience very dull conditions, and although some firms have good order books they are the exception rather than the rule, for by far the greater proportion of concerns complain of the difficulty in booking substantial new business. It is the heavier branches that are suffering most, and, with prices of a generally unsatisfactory character, it is certain that a good deal of work is being accepted on terms which can only mean a loss. Products of both iron and steel are not likely to command better prices until there has been a considerable expansion in the demand, and it must be confessed that at the moment there are no signs of that happening. In the ordinary qualities of steel Sheffield and district makers have still to face serious competition from the Continent, and the slump in railway and colliery work as a result of the continued depression in the coal industry has meant a big loss to the steel and engineering trades. There is a good deal of activity in the lighter and special steel branches, but even in them sufficient headway is not being made to counteract the depressed conditions in the heavier trades. Last week the Labour Exchange figures showed a drop of nearly 2000 in the number of Sheffield unemployed, from which one might suppose that trade was improving. Unfortunately, however, that is not the case, the decline being due merely to the fluctuations consequent upon the continual suspension and re-engagement of batches of workmen throughout the district. The irregular working at the collieries, too, is causing the unemployment returns to fluctuate considerably.

Lighter Industries.

Although the departments producing finished steel materials are fairly well employed, the position cannot be regarded as altogether satisfactory. Orders from several important markets are showing signs of falling off, and there is not the bulk about the work coming through that one would like to see. Here again there has been a good deal of price cutting indulged in following the general quietude which has settled over many of the most important branches. Buying for practically all classes of tools has declined in both the inland and overseas market, and so far the season for farm and garden tools has not given any indication that it will be of a satisfactory nature. Both plate and table cutlery have run into a quiet period. Good quality articles in particular are commanding an extremely poor sale, and the bulk of the buying is for resorts preparing for the holiday season. Other classes of cutlery, such as scissors, pen and pocket knives, present no features of particular interest.

Industrial Steels, Ltd.

It is always gratifying to hear of local firms surmounting their difficulties and making headway in these unfavourable times. In 1926 Industrial Steels, Ltd., made a net loss of £3037, but the report for 1927 just issued shows a profit, after payment of bank interest on the second and third debentures, but before providing for depreciation, of £19,220. After allowing for depreciation there is a net profit of £7353. The directors, noting the improvement in the trading results of the past year, regard them as satisfactory in view of the keen competition which prevailed in both home and foreign markets.

New Engine Depot.

The L. and N.E. Railway Company is to improve the accommodation at its locomotive depôt at Barnsley by a scheme which includes the remodelling of the existing sidings and the installation of an electrically operated coaling plant.

Electricity Developments.

The Sheffield Corporation Electric Supply Department has received permission from the Electricity Commissioners to install two 25,000-kW generators, and at the last meeting the Committee decided to install one of these only for the time being. If the scheme is approved by the Council, building extensions will begin at once. The improvements are estimated to cost £500,000, but the expenditure will be spread over a period of about four years. The new building will be made to accommodate two of these large generators. Councillor E. Snelgrove, the chairman of the Committee, states that if the scheme is passed by the Council and if the demand for electricity increases to a reasonable degree and industrial conditions improve, there is no reason to doubt that, with the aid of the new machinery, the Department will be able to reduce the electricity charges by nearly half. "The decrease would, of course, be brought about gradually," he said, "and we are looking probably four years hence when we say that the charges will be halved; but the consumers will get the benefit of the economies long before 1932 by the gradual reduction."

Hydro-electric Power Plant.

A scheme of an ambitious character for the establishment of a hydro-electric power plant at the Wash, Lincolnshire, has been promoted by the Dynamic Electrical Company, Ltd., and it is claimed that this scheme will make it possible to supply electricity in bulk at ½d. per unit. It is proposed to build two dams—a sea dam with inflow sluice gates to allow the high tide to flow into the basin at or near high-tide level, with locks, so as to allow shipping to pass, and a dividing dam to separate the full from the empty basin. The power station will be erected on the dividing dam and the maximum head will be 15ft. The sea dam will be about 12½ miles long and the dividing dam about 13 miles long. It is claimed that there are no engineering difficulties to be solved and no serious obstructions are suggested.

Greek Irrigation Contract.

The Greek Government has offered a big irrigation contract to Henry Boot and Sons, Ltd., of Sheffield and London, and Mr. Charles Boot, who is in Athens, intimates that they have every hope of being able to accept it.

Peakland Cement Works.

The large cement works at Bradwell, in the Hope Valley, near Sheffield, for Messrs. Earle, of Hull, are now in course of erection, and the construction has also begun of a light railway to connect the works with Hope Station, some 2 miles away.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Trade Outlook.

A BRIGHTER tone pervades the Northern iron and steel trade. The change in the right direction is slight, but the movement encourages hope of some early expansion of market operations. Conditions on the Continent are increasingly likely to have a beneficial influence on the situation in this district. Prices of foreign products are advancing, and manufacturers abroad are harassed by labour unrest, but buyers in this area are as yet uninfluenced by these circumstances. The outlook generally is far from what could be desired, but it appears to be brightening, not the least hopeful sign being the promise of much less keen continental competition. There seems ground for a belief in continued gradual home trade development, and signs of improvement in overseas demand are not entirely absent. Substantial increases in German manufactured iron indicate the trend of production costs on the Continent. The German manufacturers are now at a big disadvantage as compared with British producers of similar products, and a stimulus is expected to the industry in this district.

Cleveland Iron Trade.

Although there are a large number of inquiries circulating, business matures only slowly in the Cleveland pig iron trade. Ironmasters, however, are understood to have disposed of their output fairly well ahead, and are not at all perturbed by the present backwardness of buyers. Makers, with their stocks almost inconveniently small, are in a strong position, and adhere firmly to the fixed prices that have ruled for the past few weeks. A heavy proportion of the output is going into direct consumption at local works owned by producers, but users in this district, as well as in other home areas, are taking moderate supplies, while firms in Scotland are accepting rather considerable parcels. Shipments to foreign destinations are light, but improvements in exports may be reported shortly. No. 1 Cleveland foundry iron is 68s. 6d.; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; and No. 4 forge, 64s. 6d.

Hematite Pig Iron.

Conditions in the East Coast hematite pig iron trade show little change. Recent curtailment of production and further sales to home and continental customers have failed to prevent an increase in stocks. Makers have rather large accumulations at their yards, and while they are inclined to take a little firmer stand, they are still unable to book orders except at figures well below the cost of output, and there seems little likelihood of an early rise in values to a profitable level. Prices at which sales are made vary a good deal, but nominally market rates are based on mixed numbers at 70s. per ton.

Ironmaking Materials.

There is an absence of new features in the foreign ore trade. Transactions are few, but sellers, in view of a threatened shortage, are as firm as ever in their attitude. Best Rubio ore is quoted at 22s. 6d. per ton c.i.f. Tees. Blast-furnace coke keeps plentiful, and with ironmasters buying sparingly, prices are easy. Good medium Durham qualities are quoted at 17s. 6d. per ton delivered to works on the North-East Coast.

Manufactured Iron and Steel.

There are no new developments in the manufactured iron and steel trade. Nearly all descriptions are slow of sale, but manufacturers are not at all disposed to grant price concessions, and their attitude is strengthened by the upward movement in values of foreign products.

The Coal Trade.

The tone throughout the Northern coal trade is steady, both for prompt and forward, but whilst there is abundant all-round inquiry, fitters would like to see definite business booked more freely. The abundance of inquiries causes some sellers to take a strong optimistic view, but, on the other hand, doubt is expressed as to whether the inquiries are simply duplications of a few or all independent demands. The general view, however, is that the next month or two will show a substantial increase in demand, but it is not anticipated that there will be much improvement in prices, as the output can readily be increased if requirements justify that course. Consumers abroad are keen to get the best out of the alternating offers of this and other countries. There is not, perhaps, so much to fear from German sellers, as costs of production with them are now reckoned to be pretty much on a par with our own; but Poland is a formidable rival, and can secure almost as much business as she can handle, owing to the low prices and high quality, supplemented by first-class screening. For the recent Danish coal order placed in Durham, it is said that Poland quoted shillings a ton less than the offers from this neighbourhood. The order came this way, it is assumed, for reasons of reciprocity of trade rather than on actual tendering. The railway carriage of Polish coal is subsidised, which affords a big pull in final prices, and it would seem that only by subsidies is export coal anywhere likely to secure trade. Inquiries for best Northumberland steam coals are on a fairly large scale, the Baltic supplying a fair proportion of them. The collieries are well situated, and direct prices are firmly maintained. There is not much second-hand coal about now, and this fact tends to improve the position of the collieries. Best steams are fully 13s. 6d. Smalls are more favourably placed, with best qualities at a minimum of 10s. Gas coke has been selling well of late, and some of the collieries have their production bespoken to the middle of June. Best Durham gas coals command from 15s. to 15s. 3d., and seconds up to 13s. 9d. Coking coal prices are no higher, but they are a shade firmer. The coke market, whilst quiet, is fully steady for end of May and early June shipments of all descriptions. Supplies are plentiful, but steadily held; gas coke at 19s. 6d. to 19s. 9d.; patent oven cokes, 17s. to 18s.; and beehive, 24s. to 27s. There is a continued brisk inquiry for all grades of coke for shipment from July onwards, but makers will not operate except at higher prices.

Coal Miners' Wages.

The period fixed by the Independent Chairman of the District Board for the regulation of coal miners' wages in Northumberland will shortly expire, and the Miners' Association has considered the question of making another appeal for a revision of the minimum percentage, which the Independent Chairman reduced from 80 to 40 per cent. The Association, at a recent meeting of the District Board, put forward an application for a substantial increase in the minimum percentage on the basis rates. The owners, however, stated that owing to the state of trade they were unable to make any concession. At a meeting of the Council of the Miners' Association this week, it was decided to ask the branches to vote upon a proposal that an appeal be made to the Independent Chairman.

SCOTLAND.

(From our own Correspondent.)

Flax Preparation.

A NEW industry in the nature of flax preparation is to be set up at Busby, some 8 miles from Glasgow. The Pritchard Flax, Fibre and Pulp Company, Ltd., the company concerned, has acquired the works of the Calico Printers' Association at Busby, on the river Cart. These works include a number of buildings extending to 27 acres and are particularly well suited for the purpose. Water rights have also been acquired, which are capable of giving a daily supply of over three and a-half million gallons. The Pritchard Company intends to purchase the raw flax straw throughout Britain and the Colonies, to separate the fibre from the green straw where grown, and to transport the decorticated fibre to Busby to be finished into fibre for spinning. It is anticipated that this new industry will be of great advantage to Scottish agriculture and will also be a source of employment for a considerable number of workers.

Steel.

In view of firmer conditions on the Continent there is a somewhat better feeling in evidence in the home

market and makers appear to have a little more confidence in the possible improvement of trade in the near future. Evidence of this fact is given in the slight advance in the prices of certain materials for export. The present demand for heavy steel is disappointing. Specifications from shipbuilders are not sufficient to keep pace with the capacity of the plate and section mills. Rail makers in the district have booked some good export orders of late, the total being said to be about 17,000 tons.

Steel Sheets.

Black steel sheets are still rather quiet, especially the heavy gauges, while galvanised corrugated sheets, 24 gauge, for export have been quoted as low as £13 per ton.

Iron.

The bar iron and steel re-rolling works continue inactive, and while home prices are unchanged the export quotations of £9 15s. and £7 per ton might be shaded for a good specification. The pig iron market is dull, prices being still upheld by dearer costs of production.

Exports and Imports.

During the past week 8000 tons of iron ore, 2400 tons of steel and iron products, and 800 tons of steel plates were unloaded at Glasgow. Iron and steel products to the amount of 5600 tons were shipped to the Colonies, Japan, China, Spain, and South America. Shipments of pig iron amounted to 482 tons, compared with 827 tons in the same week last year.

Tubes.

The tube trade is a shade quieter. Furnaces producing butt-welded tubes are still actively engaged, but for some time past the rate of production has been greater than that at which new business has been received.

Scrap.

Supplies of scrap are not too plentiful and prices of heavy steel and cast iron are firmer at 65s. per ton.

Coal.

The position in the coal trade is not improving. Despite drastic reductions in output some collieries still experience difficulty in disposing of their productions unless price concessions are granted. Screened fuels, as a whole, however, are fairly steady, although the export turnover is confined more or less to small lots for immediate shipment. Lanarkshire splints are well booked up for this month and ells are fairly well placed. Fifeshire steams have fair bookings, but Lothians steams are not selling freely. Treble and double nuts are firm, but smaller sizes are weakening. Aggregate shipments for the past week amounted to 225,757 tons, against 245,642 in the preceding week and 242,100 tons in the same week last year. Home demands decline with the advance of the season.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

PRICE variations in steam coals during the past week have been negligible, but the position of many collieries can scarcely be said to have been quite as good as formerly, owing to the fact that the regular working of so many collieries has been interfered with by the shortage of tonnage. At the end of last week the official returns showed that there were as many as forty-nine idle loading appliances at the various docks, and this week was started under conditions none too favourable, as may be judged from the fact that on Monday there were thirty tips idle. Still, chartering has been a trifle more active of late, so that the conditions should improve slightly, though it is to be feared that this improvement will be nothing like equal to what is desired to make the majority of the collieries comfortable. Despite the tonnage position, the Customs returns of shipments last week were very satisfactory, as the total was 506,277 tons, which compared with 350,711 tons the previous week. It might appear to be very strange that there should be such a difference, more especially as the tonnage position was not better last week than the preceding week. The probability is that so far as actual shipments are concerned there was nothing like this disparity, but the reason is that shippers are allowed a certain time in which to make their returns, with the consequence that returns which rightly belong to one particular week are credited in many instances to the next. From the point of view of the demand there is no feature. A little more is being done for current shipment, but as regards supplies over a period the inquiry is slow. The Palestine Railways are in the market for 15,000 tons of Welsh large and 5000 tons of Yorkshire hards, and tenders have to be sent in by the 29th inst., but outside of this there is nothing of note.

Colliery Amalgamations.

A circular letter was sent out at the end of last week by the Powell Duffryn Steam Coal Company, Ltd., to its customers informing them that it had acquired as from the 12th inst. the collieries situated in the Rhondda Valley of the Lewis Merthyr Consolidated Collieries, Ltd., together with the coke ovens and by-product works. Rumours of other amalgamations have been current, but they have so far found no confirmation. Most interest at the moment is being directed upon possible developments in the anthracite area. Reports have been going round for some time regarding a fusion of interests between some of the bigger undertakings, and there appears to be good ground for believing that there is some truth in them, or at any rate that some negotiations have been proceeding. It is quite possible that before this week is out something of a definite character will be known, but whether the negotiations will result in a scheme of amalgamation is not too certain; it may be that an arrangement has been come to that will put an end to severe competition in the overseas markets between the leading concerns. The undertakings mentioned in connection with such a scheme are the Amalgamated Anthracite Collieries, Ltd., at the head of which is Sir Alfred Mond; the Buckland-Llewellyn group, and the Henderson and Beddoe Rees groups.

Coal Marketing Scheme.

Since the beginning of this month there has been a voluntary understanding between most of the collieries regarding minimum prices, this being only part of the scheme which was proposed by the coalowners and was embodied in the Trust Deed. For instance, there has been no levy on production to compensate collieries which through loss of trade are unable to work. The scheme has been under negotiation since last November and it had come to be regarded as tolerably certain that it would as a whole never come into operation. According to a semi-official statement, however, it appears that the existing voluntary arrangement is looked upon as merely temporary and that steps are now being taken to bring about the adoption of the full scheme as originally framed so as to make it operative as from July 2nd. Last week-end colliery companies were circularised requesting them to give their signatures to the Trust Deed. It is understood that at least 80 per cent. of the collieries are likely to fall into line, and if this turns out to be the case the scheme will come into force on the above-named date.

Subsistence Wage Issue.

The Executive Council of the South Wales Miners' Federation met on Friday last, when the subject of most interest discussed related to the subsistence wage payable to certain classes of workmen following the recent judgment in the Court of Appeal upholding the men's contention regarding the interpretation of the award of the Independent Chairman. It was decided to instruct the Federation solicitors to put in claims at once for the recovery of the arrears due to the workmen affected by the decision of the Court. Following this there was a meeting of the Joint Standing Disputes Committee of the coal trade on Monday, when the workmen's representatives raised the question of the recent judgment and asked the owners' representatives if they had a statement to make. The reply was that the Coalowners' Association had definitely decided to enter an appeal in the House of Lords against the judgment referred to.

Tin-plate Works Strike.

Unfortunately, the strike of tin-house men at the Gorseinon, Grovesend and Mardy tin-plate works, which has resulted altogether in about 2000 men being idle, has not come to an end. There is no prospect of the trouble terminating until the men recognise the constitution framed by their own side on the Industrial Council and return to work as a preliminary to the discussion of their grievances. It is estimated that as the result of the stoppage workmen have lost up to this week £10,000 in wages.

Steel and Tin-plate Works.

A report from Pontardawe states that Messrs. Gilbertsons have decided to erect another four tin mills, which will mean employment for a considerable number of hands. The work of excavation has begun. This firm now employs about 2000 hands. Owing to lack of orders in the heavy steel trade affecting the Port Talbot district Baldwins, Ltd., have disposed of the heavy mill and rolling gear which was erected at considerable expense during the war at their Margam Works. This plant is being shipped to Australia and will be re-erected at Port Kemble.

Current Business.

The general tone of the market has been a shade quieter, but there has been no alteration in values. Several of the leading concerns have been comparatively well placed for tonnage, but in other directions the supply of ready steamers has not been anything like so good, and this fact has tended to produce a certain amount of irregularity. That the conditions in the trade continue to be far from satisfactory is shown by the fact that the workmen employed at the Caerau Colliery belonging to North's Navigation Company received notices on Saturday to terminate their contracts, which for some time past have been on the day-to-day basis. Nearly 2000 men are affected by this decision.

Whitsuntide Holidays.

It has been agreed that at Whitsuntide there will be no work so far as the coal trimmers and tippers are concerned at local docks on the Whit Monday and Tuesday, and that on the Wednesday two short continuous shifts shall be worked, normal arrangements being resumed on the Thursday.

LAUNCHES AND TRIAL TRIPS.

PASS OF BALLATER, single-screw oil carrier; built by Blythswood Shipbuilding Company, Ltd., to the order of Bulk Oil Steamship Company, Ltd.; dimensions, length 200ft., breadth 30ft. 6in., depth 14ft. Engines, triple-expansion, pressure 180 lb. per square inch; launch, May 3rd.

APURE, twin-screw tank steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of Venezuela Gulf Oil Company; trial trip, May 4th.

BRITISH ARDOUR, oil tank steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of British Tanker Company, Ltd.; launch, May 4th.

HONVED, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Hungarian Levant Steamship Company, Ltd.; dimensions, 370ft. long; to carry 7500 tons deadweight. Engines, triple-expansion; constructed by North-Eastern Marine Engineering Company, Ltd.; launch, May 4th.

RIO DIAMANTE, steamship; built by William Gray and Co., Ltd., to the order of Thompson Shipbuilding Company, Ltd.; dimensions, 400ft. long, 53ft. breadth, depth 28ft. 1¼in. Engines, balanced quadruple-expansion, inverted, direct-acting, surface condensing, pressure 260 lb.; constructed by Central Marine Engine Works; trial trip, May 5th.

YORKSHIREMAN, twin-screw tug and passenger steamer; built by Earle's Shipbuilding and Engineering Company, Ltd., to the order of United Towing Company, Ltd.; dimensions, length, 126ft.; breadth, 27ft.; depth, 9ft. 6in. Engines, two triple-expansion, 10in., 16in. and 26½in. diameter by 16in. stroke; pressure, 190 lb.; launch, May 8th.

SCOTTISH CHIEF, single-screw steam oil tanker; built by Sir W. G. Armstrong, Whitworth and Co., Ltd., to the order of Tankers Ltd.; dimensions, length 455ft., breadth 56ft. 8in.; to carry 10,000 tons deadweight. Engines, inverted, direct-acting, surface condensing, quadruple-expansion, pressure 250 lb. per square inch; trial trip, May 4th.

KING CITY, steamship; built by William Gray and Co., Ltd., to the order of Sir William Reardon Smith and Sons, Ltd.; dimensions, length 400ft., breadth 14ft. 3in., depth 28ft. 0¼in. Engines, 25in., 42in., 70in. by 48in. stroke, pressure 200 lb. per square inch; constructed by Central Marine Engine Works; trial trip, May 10th.

GRETAFIELD, oil tanker; built by Cammell Laird and Co., Ltd., to the order of Hunting and Son; to carry 14,400 tons. Engines, single-screw balanced quadruple-expansion; trial trip, May 11th.

CABO RASO, single-screw tug and salvage steamer; built by Harland and Wolff, Ltd., to the order of McKie and Baxter, Ltd., for the Lisbon Harbour Board; dimensions, length 120ft., breadth 25ft., depth 12ft. 6in. Engines, triple-expansion, surface-condensing; constructed by the builders; handed to owners on May 15th after running satisfactory trials.

CATALOGUES.

HIGGS MOTORS, Witton, Birmingham.—Latest price list of alternating-current and direct-current motors.

THE RILEY STOKER COMPANY, Ltd., 9, Bridge-street, S.W. 1.—Catalogue describing in detail the "Rileyturbo" stoker.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby.—Descriptive list No. 653 of electric printing press equipments.

WILLIAM ASQUITH (1920), Ltd., Halifax.—Two catalogues of high-speed drilling machines for railway work and portable universal radial drilling machines.

THE SHEFFIELD TWIST DRILL AND STEEL COMPANY, Ltd., Summerfield-street, Sheffield.—A hundred-page booklet of drills, reamers and milling cutters of all types.

STURTEVANT ENGINEERING COMPANY, Ltd., 147, Queen Victoria-street, E.C. 4.—Catalogue No. 1235 in four sections:—(1) Fans, (2) Systems and Plants, (3) Apparatus, (4) Crushing, Grinding and Screening Machinery.

CALLENDER'S CABLES AND CONSTRUCTION COMPANY, Ltd., Hamilton House, Victoria Embankment, E.C. 4.—A book entitled "Callender Overhead Construction," describing in detail transmission and distribution lines, railway electrification, cable bridges, &c.

SAMUEL OSBORN AND CO., Ltd., Clyde Steel Works, Sheffield. The following set of catalogues:—"Reamers in Mushet Steel," "Chisels and Snaps for Pneumatic Machines," "Twist Drills in Mushet Steel," "Rust-resisting Steels and Irons," "Tool and Special Steels," "Springs," "Automobile and Aircraft Steels," "Carbon Tool Steels," "Files."

ROD PACKING.—We have received from Allan Clayton, Ltd., of 45, Russel-street, Leamington Spa, a sample of "Granola" plastic metallic packing, which has been compressed into a piston-rod gland. The material appears to be a compost of fibre, grease, graphite, and small lead shot, and is, we are told, sent out in rolls of 2 lb. each. The strand is supplied in a uniform thickness regardless of the size of the box which has to be packed and is roughly moulded by hand to approximate shape before being put in place. From the sample which we have before us it appears that the mass settles down into a homogeneous ring fitting closely in the box and round the rod. The lubricating values of its constituents need no comment. It is claimed that it will serve equally well for saturated or superheated steam, hot or cold water and most liquids, except petrol and strong caustic liquor.

ENGINEERING GOLFING SOCIETY.—The spring meeting of the Engineering Golfing Society was held on the course of the Tandridge Golf Club on Tuesday last, the 15th inst. In the morning round—an eighteen-holes stroke competition under handicap—the President's Challenge Cup and Memento were won by W. L. Mansergh with 89 − 8 = 81, and the Wilson Challenge Cup and Memento by W. R. Manning with 91 − 11 = 80. The First Division Second Prize went to P. L. Riviere with 85 − 3 = 82 after a tie with C. W. Myddleton, 85 − 3 = 82, and the Second Division Second Prize to K. W. Macnee with 99 − 18 = 81. The Sealed Nine-hole Prizes—given by the Captain—were awarded as follows:—First Division, C. W. Myddleton with 38 − 1½ = 36½, and Second Division, K. W. Macnee with 46 − 9 = 37. In the afternoon, in a four-ball foursomes round, match play against bogey, there was a triple tie at 3 up. The prizes were awarded as follows:—Timmis Challenge Cups and Mementoes, J. H. Skelton and P. V. Hunter; Second Prizes, G. N. Watney and C. Stewart, and S. Price Williams and S. C. Lewis. There were fifty-one competitors.

INSTITUTION OF MECHANICAL ENGINEERS.—Members of the North-Western Branch of the Institution of Mechanical Engineers to the number of about a hundred spent a very pleasant afternoon on Thursday, May 10th, at the Mersey Ironworks, Ellesmere Port, belonging to the Wolverhampton Corrugated Iron Company, Ltd. The party was received by the managing director, Mr. F. Jones; the works Manager, Mr. R. Peverley; and members of the staff. Luncheon was kindly provided by the company, and the visitors were then conducted round the works, which extend for over half a mile. They are arranged for the manufacture of galvanised corrugated steel sheets, Robinson "protected metal," and a special type of ventilator. The protected metal is coated on each side with bitumen, wrapped in a sheet of asbestos, and is finally coated with another layer of bitumen of a much stronger and harder character. The total output of this metal is over 3000 tons per week, and the works are designed to reduce manual labour to a minimum. Continuous production from the bar to the finished sheets is maintained. The general lay-out of the works includes the following:—Patternmaking shops, bar shed with bar shearing machine, conveyor and packers; rolling mills, of which there are twenty-five, twenty-one driven by three steam engines and four by electric motors; one-third of the steam required for the engines is produced by waste heat boilers. Other departments visited were the shear building, where the sheets are cut square and cold rolled; a close annealing shop with a furnace 100ft. long; a pickling and galvanising shop; a corrugating shop and general stores. A demonstration was given of apparatus for testing the efficiency of various types of ventilators under different conditions. Tea was served at the conclusion of a most enjoyable visit, and a vote of thanks to the company, proposed by Mr. A. Saxon and seconded by Dr. T. Morley, was carried by acclamation.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/- to 21/-
(1) Spanish	19/- to 21/-
(1) N. African	19/- to 21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 14 0	—
No. 1 Foundry	3 15 0 to 3 16 0	—
No. 3 Foundry	3 10 0 to 3 11 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 10 0	3 10 0
No. 1	3 10 6	3 10 6
Cleveland—		
No. 1	3 8 6	3 8 6
Silicious Iron	3 8 6	3 8 6
No. 3 G.M.B.	3 6 0	3 6 0
No. 4 Foundry	3 5 0	3 5 0
No. 4 Forge	3 4 6	3 4 6
Mottled	3 4 0	3 4 0
White	3 4 0	3 4 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
,, ,, Foundry	3 2 6	—
(3) Northampton—		
Foundry No. 3	2 18 0 to 2 19 0	—
Forge	2 13 6	—
(3) Derbyshire—		
No. 3 Foundry	3 3 6 to 3 4 6	—
Forge	2 19 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 3 6	—
No. 4 Forge	3 1 0	—
Basic	3 0 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 2 0 (a); 4 5 0 (b); 4 8 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
LANCS.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	10 10 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 5 0 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 17 6 to 9 0 0	—
Gas Tube Strip	11 0 0	—

STEEL. (d)

	(6) Home. £ s. d	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ¾in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 12 6	8 10 0
Sheets (Gal. Cor. 24 B.G.)	13 5 0	13 0 0

STEEL (*continued*).

	Home. £ s. d	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	7 12 6	—
Soft Billets	6 15 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	7 10 0 to 10 0 0	—
MANCHESTER—		
Bars (Round)	8 17 6	—
,, (Small Round)	7 12 6	—
Hoops (Baling)	10 5 0	10 0 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6	—
,, (Lancs. Boiler)	10 0 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Hard Basic	7 2 6 to 7 12 6	—
Intermediate Basic	7 0 0	—
Soft Basic	6 5 0	—
Hoops	9 10 0 to 10 10 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars	7 5 0 to 8 0 0	—
Billets and Sheet Bars	5 15 0 to 6 0 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 0 0 to 13 2 6	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	11 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/6 to 18/7½
Block Tin (cash)	232 10 0
,, (three months)	232 0 0
Copper (cash)	62 10 0
,, (three months)	62 15 0
Spanish Lead (cash)	20 6 3
,, (three months)	20 13 9
Spelter (cash)	26 6 3
,, (three months)	25 18 9
MANCHESTER—	
Copper, Best Selected Ingots	66 10 0
,, Electrolytic	67 15 0
,, Strong Sheets	92 0 0
,, Tubes (Basis Price), lb.	0 1 1
Brass Tubes (Basis Price), lb.	0 0 11½
,, Condenser, lb.	0 1 2
Lead, English	22 0 0
,, Foreign	20 17 6
Spelter	26 15 0
Aluminium (per ton)	£107

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/7½ per lb.	
Ferro Tungsten	1/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 10 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 2 6	7/-
,, ,, 8 p.c. to 10 p.c. ,,	£22 0 0	6/-
,, ,, Specially refined		
,, ,, Max. 2 p.c. carbon	£35 0 0	12/-
,, ,, ,, 1 p.c. carbon	£40 10 0	15/-
,, ,, ,, 0·70 p.c. carbon	£46 10 0	17/-
,, ,, ,, carbon free	1/2 per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (per ton)	£13 10 0 for home; £13 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 10 0 scale 6/- per unit	
,, Vanadium	14/3 per lb.	
,, Molybdenum	4/6 per lb.	
,, Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.
(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/9
,, ,, Ell	14/6
,, ,, Splint	16/3 to 17/-
,, ,, Trebles	13/3
,, ,, Doubles	12/3
,, ,, Singles	11/3
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/6
,, ,, Jewel	15/6
,, ,, Trebles	12/9
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	11/- to 13/-
Screened Navigation	18/-
Trebles	12/3 to 12/9
Doubles	12/3 to 12/6
Singles	11/3
LOTHIANS—	
(f.o.b. Leith)—Best Steam	11/6 to 12/-
Secondary Steam	11/3
Trebles	12/3
Doubles	12/-
Singles	11/3

ENGLAND.

(8) N.W. COAST—	
Steams	24/- to 25/-
Household	37/6 to 50/-
Coke	22/6 to 23/6
NORTHUMBERLAND—	
Best Steams	13/6
Second Steams	11/9 to 12/-
Steam Smalls	9/- to 9/6
Unscreened	11/9 to 12/-
Household	21/- to 27/-
DURHAM—	
Best Gas	15/-
Second	13/3 to 13/9
Household	21/- to 27/-
Foundry Coke	17/6 to 18/-
SHEFFIELD—	Inland.
Best Hand-picked Branch	27/6 to 29/6 —
Derbyshire Best Bright House	20/6 to 21/6 —
Best House Coal	19/- to 20/6 —
Screened House Coal	16/- to 17/6 —
,, ,, Nuts	15/- to 16/- —
Yorkshire Hards	15/- to 16/- —
Derbyshire Hards	15/- to 16/- —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	6/- to 7/- —
Smalls	3/- to 4/6 —
Blast-furnace Coke (Inland)	13/- at ovens —
Furnace and Foundry Coke (Export), f.o.b.	16/9 to 17/6

(9) SOUTH WALES.

CARDIFF— Steam Coals:	
Best Smokeless Large	19/3 to 20/-
Second Smokeless Large	18/6 to 19/-
Best Dry Large	18/- to 18/9
Ordinary Dry Large	17/3 to 18/-
Best Black Vein Large	17/3 to 17/9
Western Valley Large	16/9 to 17/3
Best Eastern Valley Large	16/6 to 17/3
Ordinary Eastern Valley Large	16/3 to 16/6
Best Steam Smalls	12/6 to 13/-
Ordinary Smalls	11/- to 12/6
Washed Nuts	17/- to 21/-
No. 3 Rhondda Large	19/6 to 20/-
,, ,, Smalls	14/- to 14/9
No. 2 ,, Large	16/- to 16/6
,, ,, Through	14/6 to 15/6
,, ,, Smalls	12/6 to 13/6
Foundry Coke (export)	30/- to 37/6
Furnace Coke (export)	27/6 to 30/-
Patent Fuel	21/6 to 22/6
Pitwood (ex ship)	27/6 to 28/-
SWANSEA— Anthracite Coals:	
Best Big Vein Large	32/- to 35/-
Seconds	24/6 to 27/6
Red Vein	20/6 to 27/-
Machine-made Cobbles	40/- to 42/6
Nuts	37/6 to 42/6
Beans	23/- to 27/-
Peas	17/9 to 19/-
Breaker Duff	8/- to 8/6
Rubbly Culm	10/- to 10/6
Steam Coals:	
Large	17/6 to 18/6
Seconds	16/- to 17/-
Smalls	10/- to 12/-
Cargo Through	15/- to 16/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.
(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield.
(c) Delivered Birmingham. (d) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our own Correspondent in Paris.)

Improved Outlook.

DURING the long period of limited buying there was a depletion of stocks, and now that a little more activity is observable in constructional work, those stocks have to be replenished, with the result that many orders have been placed for iron and steel and the situation has undergone a distinct improvement. It is, however, the larger demand from foreign markets that imparts a more confident tone to trade, and there is an impression that if China would cease from fighting and settle down to business the future would be extremely hopeful. As it is, the foreign demand in Belgium has so far improved that steelmakers are reported to have decided to apply for an augmented production at the next meeting of the Cartel. Nevertheless, the foreign outlook is rendered less secure by the increasing production costs, which are automatically rising now that living costs are steadily though almost imperceptibly increasing, as the result partly of the heavier fiscal charges. Wages are slowly advancing. It is hoped to keep prices for export at a competitive level by securing higher prices at home, but it is obvious that there is a limit to the prices that home consumers will pay and that limit has certainly almost been reached. So far French and other steel firms have had matters much their own way, but the economic advantages they have enjoyed are becoming less obvious, and with higher wages and heavier charges the margin of production costs in their favour is being reduced.

A French View of British Industry.

The eminent economist, M. A. Siegfried, spent some time in England recently in order to study the industrial situation, and in a Conference at Lyons he gave his impressions of the changes that appear to be taking place in British industry. The British, he said, owed their former prosperity to a virtual monopoly of the coal trade, which enabled them to manufacture much more cheaply than their competitors, but that that advantage was now lost because most other countries were manufacturing and producing as much as they could for their own needs, and even exporting under favour of the higher production costs in Great Britain. The reasons for the contraction of British exports were, affirmed M. Siegfried, a return to the gold standard without there being a gradual reduction of wages, the use of out-of-date machinery and plant, the individual character of manufacturers, who were averse from anything in the nature of organisation and syndicates, which aimed at controlling production, the absence of mass production, the lack of technical training amongst employers, and the "demoralisation" of the working classes, who had been receiving higher wages without making any attempt at increased efficiency. That was, M. Siegfried continued, an important factor in the heavier production costs. Then there were a million of unemployed who were imposing a heavy and deadly burden upon the country. Above all that, there was the uncontrovertible fact that coal had been displaced by oil and hydro-electric energy. Great Britain spent more upon the importation of oils than she gained upon the export of coal. Nevertheless, Great Britain was adjusting herself to the new condition of things. There was no falling off in the standard of living, and if the balance of trade showed a considerable deficit it was made up for by invisible exports, which meant that Great Britain was becoming more and more the great creditor of Europe. She knew that, in financing foreign countries, she was preparing for future custom. The present was the concluding phase of the development which began in the nineteenth century. Great Britain, added M. Siegfried, is returning to what she was in the seventeenth and eighteenth centuries, that is to say, a great maritime, commercial and financial power.

Railway Economies.

In view of the heavy deficit of the railway companies, which is due largely to a diminution of goods traffic following upon the increased rates, competition of road transport and a decline of industrial activity, a commission was appointed to investigate the ways and means of effecting economies and, at the same time, of adapting the new rates to special conditions of transport in a way that will lessen the burden upon users. The Compagnie du Nord has not waited for the Commission to terminate its inquiry before starting upon a policy of economical reform. So much of the trouble arises from the application of the eight hours' working day, which meant an increase of about 30 per cent. in the number of men employed, that the Compagnie du Nord has tackled the problem at its origin and is carrying out a complete organisation of work with the object of reducing considerably the number of railwaymen. Taking as an example two stations where trains are made up and despatched and where the conditions are not modified by the ordinary traffic and therefore provide a fair comparison, it is found that in a modern station suitably equipped with labour-saving devices two men will deal with the arrival of 10,000 trucks, while in the old station 3·65 are required for the same work, thereby effecting an economy in labour of 32·6 per cent. The same economy has been obtained in the locomotive sheds. By installing mechanical devices it has been found possible to reduce the number of men per locomotive from 2·68 to 1·82. The methods of maintaining the permanent way have also been improved, and on 222 kiloms. of double track the number of men has been reduced from 262 to 202, representing an economy of 23 per cent. During the past year many important works have been carried out, notably the suppression of a large number of level crossings.

Ingenieurs Civils.

The Société des Ingénieurs Civils has celebrated its eightieth anniversary by inviting engineers from all over Europe to visit France. Visitors were received at Lille, and then visited Lens, Dunkirk, Havre and Rouen, and finally Paris, where they were shown the power station at Gennevilliers, the new works in progress at the Gare de l'Est, and the electrified line from Paris to Orleans. The foreign engineers met with an extremely cordial reception and their visit was of a highly informative character.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

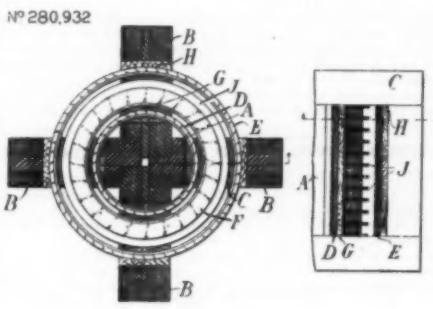
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

ELECTRICAL APPLIANCES.

280,932. November 17th, 1927.—IMPROVEMENTS IN AND RELATING TO TRANSFORMERS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.* 2.

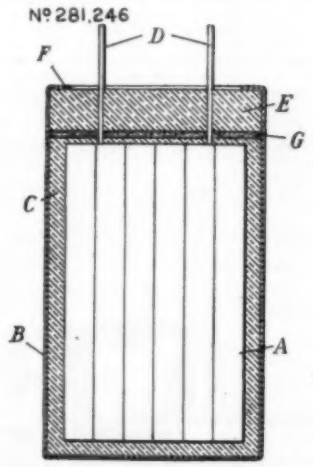
This specification describes a transformer of the core type, and the object is to provide an improved arrangement of windings, whereby the transformer may have low reactance and the high-voltage winding may be well insulated and ventilated and easily accessible. The transformer has a centre leg A and four outer legs B, and the centre and outer legs are connected by yokes. The low and high-voltage windings surround the centre core, and the low-voltage winding is formed in the two spaced concentric sections D and E, whilst the high-voltage winding F consists of a stack of disc coils, placed concentrically between the



two sections of the low-voltage winding. With this arrangement the reactance of the transformer will be low. The inner section D of the low-voltage winding and the high-voltage winding are supported radially by the centre core leg A and are separated by spacers G to provide a ventilating duct. The outer section E of the low-voltage winding is spaced from the high-voltage winding F and is supported radially entirely by the surrounding outer legs B of the core, blocks or spacers H being interposed if desired. The disc coils of the high-tension winding F are spaced and insulated from each other by collars J of insulating material, the edge portions of these collars extending beyond the outer faces of the coils and into the surrounding space, so as to increase the breakdown leakage paths between adjacent coils.—*April 5th*, 1928.

281,246. November 2nd, 1927.—IMPROVEMENTS IN ELECTRICAL CONDENSERS, *Dubilier Condenser Company* (1925), *Ltd., of Ducon Works, Victoria-road, North Acton, London, W.* 3.

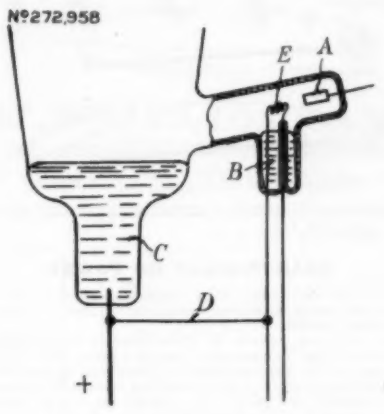
This invention relates particularly to electrical condensers that are impregnated with a filler of insulating material in the course of the manufacture. The object of the invention is to provide an improved means of sealing. A more rapid assembly of the closure or barrier between the filler and the sealing compound and of the sealing compound itself is also obtained. The body of the condenser A may comprise one or more sections, and many include sheets or strips of some electrical conductive substance such as metal foil separated by insulation such as paper, and after the body is formed it may be impregnated



by immersing in melted wax. It is then placed in a container B which may be of sheet metal, cardboard or other material, and into this container is poured a liquid insulating compound such as wax, indicated at C. One end of the casing may be open, and through this end the terminals D may project. This open end of the condenser is closed with material such as wax E to seal the body of the condenser in the casing A and to cover both the body and the wax C, and the edges of the open end of the container B may be crimped over upon the sealing material E, as indicated at F. The disadvantage incident to the use of a sheet of fibre between the filler C and sealing compound E can be eliminated by the use of a layer of sharp silica or other material of high insulating qualities, this layer being indicated at G.—*April 5th*, 1928.

272,958. June 20th, 1927.—IMPROVEMENTS IN ELECTRIC MERCURY VAPOUR APPARATUS AND THE LIKE, *The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.* 2, *and Ezechiel Weintraub, of* 14, *rue des Marronniers, Paris, France.*

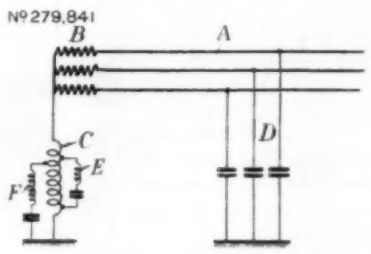
In a mercury vapour rectifier constructed in accordance with this invention, the arc is started by means of an auxiliary arc, which is initiated in a side arm of the container by means of a conductor heated to incandescence, so as to cause the formation of ionised mercury vapour. In the drawing the starting electrode



is shown at A. A small quantity of mercury which forms the auxiliary cathode is placed in the side arm at B, and the two cathodes B and C are joined by a conductor D. The ionised mercury vapour is produced by a filament E.—*April 12th*, 1928.

279,841. October 22nd, 1927.—MEANS FOR SUPPRESSING THE EARTH CONNECTION CURRENT IN HIGH-TENSION ELECTRIC MAINS, *Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.*

This specification describes a device for the suppression of earth connection current in high-tension mains. A is a three-phase main fed by a generator or transformer B. Connected to the neutral point of the generator or transformer there is a choking coil C, designed so that at the frequency of the working voltage it is in resonance with the capacity of the mains indicated by the three condensers D. A portion of the choking coil is bridged by the circuit E, containing an inductance and capacity in

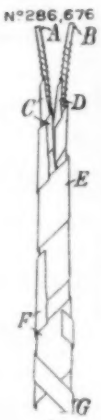


series, and dimensioned so that their reactance cancels each other for a given harmonic, say, the fifth harmonic of the working frequency. Moreover, this connection is joined to the choking coil C in such a manner that a portion of the choking coil in combination with the earth capacity of the mains has a natural frequency equal to the fifth harmonic. As the connection E has a very high resistance at the working frequency, the choking arrangement will, in the event of an earth connection on the lines, compensate both the earth connection charging current with the fundamental wave and the fifth harmonic of the wave. If there is another pronounced harmonic, another circuit may be provided to cope with the harmonic as shown at F.—*April 19th*, 1928.

TELEGRAPHS AND TELEPHONES.

286,676. March 8th, 1928. AN ELECTROSTATIC PROTECTING COVERING OF CABLE CORES, Felten and Guilleaume Carlswerk Actiengesellschaft, of Köln-Mülheim, Germany.

The practice of surrounding the cores, double cores, quads and groups of cores of a cable with an electrically conducting covering, in order to avoid electrostatic disturbances by adjacent conductors and consequently cross-talk is already known. According to the invention, a copper band is wound over the covering of metallised paper with a great distance between the turns, and the copper band touches the metallised surface of the covering. In this way a very good conductivity is imparted to the covering over its whole length and, experiments have shown, that it suffices to fulfil the highest requirements with respect to the cross-talk damping. The coverings may be earthed in the junction sleeves of the cable. The accompanying drawing illustrates a form of construction according to the invention. A and B are the two conductors which are provided with a string winding. C and D is the paper insulation provided on the individual cores, free spaces being left which correspond to the thickness of the string. E is an additional layer of paper band which surrounds the two cores. F is the closed covering of metallised paper, and G is the strip of copper which is wound on in an open helical form.—*April 12th*, 1928.



AERONAUTICS.

288,027. April 5th, 1927.—WINGS FOR AIRCRAFT, Sir W. G. Armstrong, Whitworth Aircraft, Ltd., F. M. Green, and J. Lloyd, Park Side Coventry.

The object of this invention is to provide supplementary supporting surfaces which will automatically increase the lift coefficient of the wing at low speeds or large angles of incidence, and also provide for better control under such conditions. An auxiliary aerofoil is arranged in front of the wing, and its movement towards or away from the leading edge of the latter is

effected by interconnecting it with a trailing flap adapted to move automatically, either owing to its weight, position of hinging, by spring pressure, or by any or all of these combined. The

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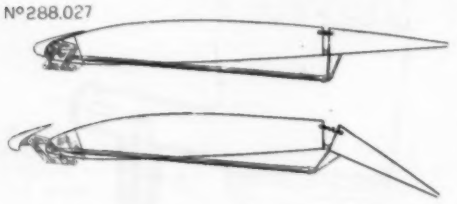

arrangement is so obvious in the drawing as to need no description.—*April 5th*, 1928.

TRANSMISSION OF POWER.

284,195. January 23rd, 1928.—Improvements in Variable-speed Gear, Chambon, Ltd., of 23 and 25, Sandland-street, London, W.C. 1.

This invention relates to improvements in variable-speed gear of the type comprising a pair of friction discs and a pair of friction rollers disposed between and rolling against the discs and against one another and capable of being displaced radially with respect to the discs. The driving movement is received by the pulley A and transmitted by the shaft to the discs B and C. The rollers E and F are rotated as a result of the drive caused by the friction set up between the rollers and under the pressure of the springs G. The rotation of the rollers is transmitted to the shafts H and J, the worms K, L, M and N, the wheels O, P, Q and R, and, finally, to the shafts S and T. It

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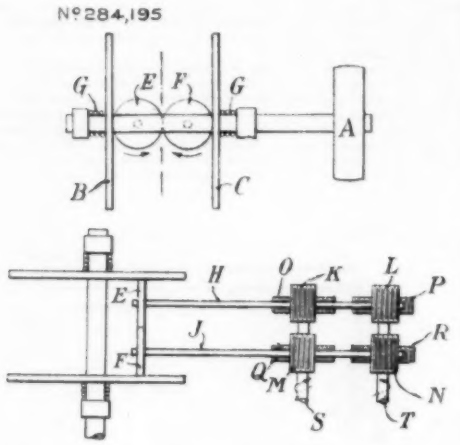

will be seen that the shafts H and J rotate at the same speed, but in contrary directions, with the result that the wheels O and Q rotate at the same speed and in the same direction on account of the opposite hands of the screw threads of the worms K and M. Consequently, the wheels O and Q can be mounted on a common shaft S, and both serve for driving it. It will also be seen that the shaft T is driven in a similar manner to that of the shaft S. The speed of the shafts S and T is varied by the displacement of the rollers E and F radially on the friction discs B and C. In this manner, any variation between predetermined limits of speed of the rollers, and consequently of the shafts S and T, can be obtained. The axial displacement of the rollers E and F may be effected in any suitable manner. The variable gear mechanism is claimed to be particularly suitable for use on printing machines.—*April 12th*, 1928.

288,483. September 17th, 1927.—Improvements in and connected with Clutches for Motor Vehicles and the like, Horace Royal Dickinson, Almorah, Mumbles-road, Derwen Fawr, Swansea, Glamorgan, and Herbert Kitchener Bassett, of Rosehill, Swansea, Glamorgan.

A clutch constructed in accordance with this invention comprises a plate clutch A combined with any usual form of friction

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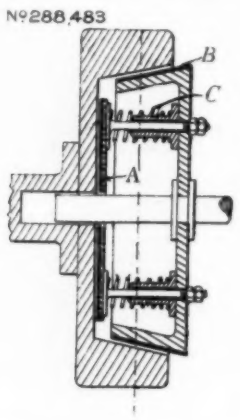

clutch B, the plate clutch being provided with adjustable springs C and a driving connection to the usual clutch, so arranged that in the clutching operation the plate clutch is applied before the other clutch comes into operation, and in de-clutching the usual clutch is disengaged before the plate clutch. The advantage claimed for the clutch is that it takes up the load more gradually than usual.—*April 12th*, 1928.

FURNACES.

288,072. July 18th, 1927.—Cupolas, A. H. Coplan, 7, Clemow-avenue, Ottawa, Ontario.

Here we have a specification in which, with the aid of a brief quotation and an illustration, the ideas of the inventor are disclosed. The illustration needs no comment, and the quotation is as follows :—The invention consists in substituting, in a cupola, for the usual refractory lining, an inner wall of heat resisting steel spaced from the outer wall of the cupola to form a continuous air chamber, and providing air blast admission means at the lower end of said chamber and heated air discharge means at the upper end of said chamber, means connected with the air discharge means for delivering and distributing the heated air to the heating chamber of the furnace, and means associated with the air blast inlet for delivering the air into said chamber in a tangential direction, in combination with peripheral ribs

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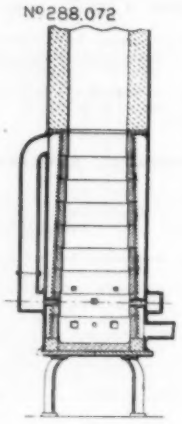

integral with the inner wall, but spaced from the outer wall, for directing the air in the air chamber while absorbing the heat radiating from said inner wall. Preferably the outer face of the inner wall is formed with a continuous peripheral helix forming corrugations or ribs spaced from the outer wall, whereby in combination with the air blast, a cyclonic effect is imparted to the air passing through the air chamber.—*April 5th*, 1928.

MACHINE TOOLS AND SHOP APPLIANCES.

273,297. June 21st, 1927.—Improvements in or relating to Locally Fusing Metals by the Electric Arc Process and to Electric Arc Welding, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

This invention relates to improvements in methods of locally fusing metal by the electric arc process. In the arrangement shown, argon is supplied from a suitable source, through

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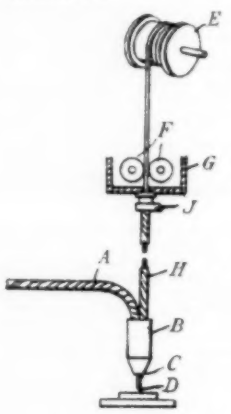

a flexible conduit A to a welding tool B, from which it is discharged around the welding electrode C and the molten portions of the work D. In place of argon, mixtures of other gases containing argon might likewise be supplied. The electrode C is indicated as being drawn from a reel E by feed rollers F driven by any suitable means. The feed rollers are mounted in a welding head G. The electrode is delivered from the rolls F to the tool B by a flexible conduit H. Welding current is supplied at J from any suitable source.—*April 12th*, 1928.

MOTOR CARS AND ROAD TRAFFIC.

288,410. February 21st, 1927.—Improvements in and relating to Distributors for Magneto-electric Machines, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2; Leonard Griffiths, of 18, Grafton-street, Coventry, and Frederick Ambrose Fossey, of 4, Harris-road, Stoke, Coventry.

The object of this invention is to prevent stagnation of the

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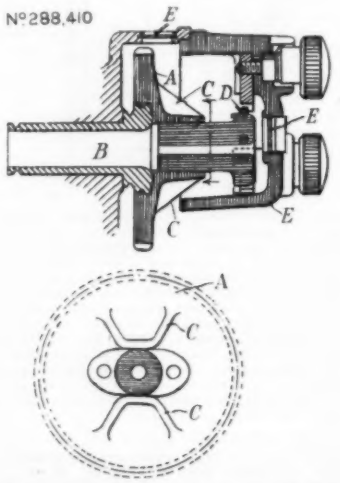

air inside the distributor chamber of a magneto. The desired object is obtained by providing four blades or fins on the distributor gear wheel. This gear wheel A, with its spindle B and fins C, carries an insulating block fitted with an electrode D which co-operates with the segments and terminals of the distributor moulding E to distribute the high-tension current to the various sparking plugs. A small air gap is provided between the distributing electrode D and the distributor segments, across which the high-tension currents jump, and the consequent ionisation of the air necessitates ventilation. The purpose of the fins C is to keep the air inside the distributor casing in circulation, and to this end ventilating gauzes E are provided, so that air is drawn in axially and expelled in a radial direction.—*April 12th*, 1928.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Royal Institution of Great Britain.—21, Albemarle-street, W. 1. Discourse, "The Sea in Fiction," by Mr. Morley Roberts. 9 p.m.

TUESDAY, MAY 22ND.

Illuminating Engineering Society.—32, Victoria-street, S.W. 1. Annual meeting at Home Office Museum, Horseferry-road, S.W. 1. 6 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "The Gambia Colony and Protectorate," by Captain Sir Cecil Armitage. 4.30 p.m.

The Institution of Locomotive Engineers (London).—Visit to Manchester Ship Canal. Leave Euston 8.30 a.m.

WEDNESDAY, MAY 23RD.

Institution of Municipal and County Engineers.—Southern District meeting at the Refinery at Fawley, near Southampton. 12.10 p.m.

THURSDAY, MAY 24TH.

Institution of Municipal and County Engineers.—East Midland District Meeting.—At Council Chamber, Council Offices, Station-road, Hinckley. 11.15 a.m.

FRIDAY, MAY 25TH.

Royal Institution of Great Britain.—21, Albemarle-street, W. 1. Discourse, "Engine Knock and Related Problems," by Mr. A. C. Egerton, F.R.S. 9 p.m.

THURSDAY, FRIDAY AND SATURDAY, MAY 31ST TO JUNE 2ND.

The Institution of Municipal and County Engineers.—The Hydro, Peebles. Scottish District meeting.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Thos. W. Ward, Ltd., of Sheffield, has acquired for dismantling purposes the works of the Ashbury Railway Carriage and Iron Company, Ltd., Manchester.

Clayton and Shuttleworth, Ltd., of Lincoln, inform us that they have been awarded the silver medal—highest award—at the Dublin Agricultural Show for their 30 B.H.P. electric type cold-starting heavy oil engine of the Clayton-Babcock design.

CONTRACTS.

The General Electric Company, Ltd., has received an order from the London United Tramways for one hundred and two 50 horse-power tramcar motors, W.T. 28 M.L.

Braithwaite and Co., Ltd., of Broadway Buildings, Westminster, London, S.W. 1, have been awarded a contract for the supply of a combined road and railway bridge over the river Hooghly at Calcutta. The bridge, which will weigh 17,000 tons, will consist of seven spans each of 360ft.

John I. Thornycroft and Co., Ltd., inform us that they have received from the Parsons Marine Steam Turbine Company, Ltd.—which has itself obtained an order from the British Admiralty for one of the eight destroyers comprising the 1927–8 programme, on which machinery of a special type with high-pressure steam is to be installed—an order for the hull and boilers of that vessel.

British Brown-Boveri, Ltd., informs us that its organisation has received an order from the New South Wales Government Railways and Tramways for ten additional sets of power rectifiers similar to those which it supplied to the Gordon sub-station in 1925. The rectifiers are 1500 kW, 1500-volt, direct-current units with an overload capacity of 25 per cent. for two hours, 50 per cent. for twenty minutes, 100 per cent. for three minutes, 200 per cent. for one minute, and 300 per cent. for peak loads. They are to be supplied on the primary side with three-phase, 50-period current at 33,000 volts, and will be installed in the Gordon, Epping, Granville, Sefton and Cabravale sub-stations.

Meldrums Ltd., of Timperley, near Manchester, has during the past few months received orders for its forced draught furnaces with smoke consumer for some eighty boilers, mainly of the Lancashire and Cornish types. These orders have come from various industries, including collieries, brickworks, chemical works, art silk works, iron and steel works, laundries, woollen mills, cement, lime and pottery works, gasworks, hat works, furniture works, flour mills, institutions, &c. During the same period forty-five Meldrum refuse destructors, ranging in size from the small domestic type burning 25 lb. of refuse per hour up to those for trade and municipal purposes, were ordered.

Royal Aeronautical Society.—At a meeting of the Council of the Royal Aeronautical Society—with which is incorporated the Institution of Aeronautical Engineers—held on May 8th, 1928, Colonel the Master of Sempill was unanimously elected President for the ensuing year, 1928–1929. Air Vice-Marshal Sir Vyell Vyvyan, K.C.B., D.S.O., was re-elected Vice-President, and Lieut.-Colonel J. T. C. Moore-Brabazon, M.C., was elected an additional Vice-President.